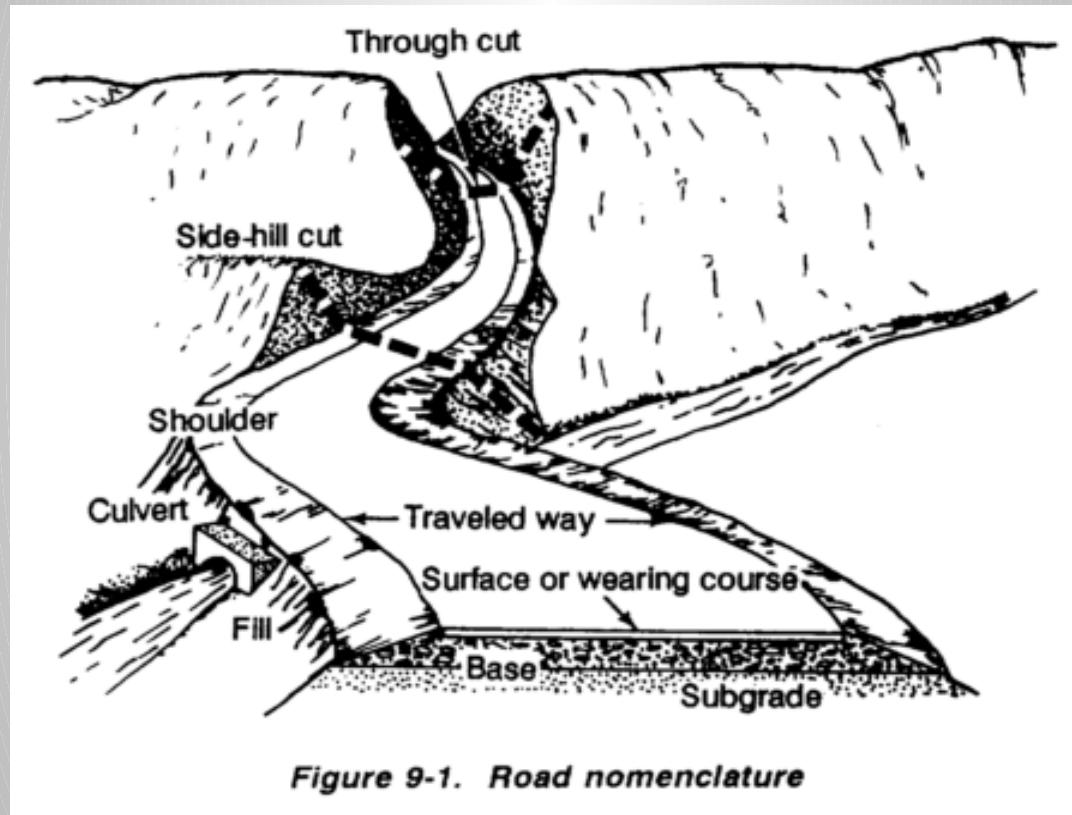


# MILITARY ROADS



GySgt Hill.

# OVERVIEW

- The purpose of this period of instruction is to provide you the knowledge to identify basic requirements, design, plan, and supervise military road construction to meet specifications for vehicle type and traffic quantity.

# **LEARNING OBJECTIVES**

- Terminal Learning Objective
- Enabling Learning Objective

# METHOD/MEDIA

- Lecture method
- Power point
- Demonstration
- Practical application
- Dry erase board

# EVALUATION

- Written exam

# **SAFETY/CEASE TRAINING**

- Inclement weather procedures
- Fire procedures

# MILITARY ROADS

- Questions:
  - What is taught?
  - How it will be taught?
  - How you will be evaluated?

# **SITE RECONNAISSANCE**

- Checking feasibility
- Checking for alternate route(s)

Who should conduct it?

- Project Officer
- Engineer Chief
- Engineer Assistant

# **SITE CONSIDERATIONS**

- Terrain Restrictions
- Existing Roads
- Existing Bridges
- Natural and Manmade Obstacles
- Vegetation and Undergrowth
- Engineering effort required

# **SITE CONSIDERATIONS**

- Existing soil Conditions
- Possible barrow pit locations

# PRELIMINARY ROAD LOCATION FACTORS

- Soil Characteristics: Locate roads on terrain having the best sub grade soil conditions to decrease construction efforts and make a more stable road.
- Drainage: Locate roads in areas that drain well, and where the construction of drainage structures is minimized.
- Topography: Avoid excessive grades and steep hills. Locate roads on the side of a hill instead of going directly over it.

# PRELIMINARY ROAD LOCATION FACTORS

- Earthwork: Earthwork operations are the single largest work item during the construction of a road. Balancing cut and fill volumes will decrease hauling distances, and the work required to handle the material.
- Alignments: Keep the number of curves and grades to a minimum. Avoid excessive grades which cause mobility problems.

# **FINAL ROAD LOCATION**

- Co-locate with existing roads
- Locate on stable soil mass
- Avoid high water tables
- Locate along natural contours
- Avoid rockwork and excessive  
Clearing Grubbing & Stripping
- Avoid sharp curves, grades and  
gaps

# **RECORDING OBSERVATIONS**

- Make your notes as detailed as possible when performing the site reconnaissance.
- Use a rough checklist to help you with your site observations.  
(student handout)
- Make a rough sketch of the

# QUESTIONS?



# DRAINAGE



# **PROPER DRAINAGE**

- Inadequate drainage is the #1 killer of a road system
- Proper drainage is a must before, during and after construction
- Proper drainage ensures that surface water is carried away from the road surface

# **EFFECTS OF IMPROPER DRAINAGE**

- Washouts
  - Culverts
  - Bridges/abutments
  - Road Bed
  - Weakens sub grade and base course of the road

# CULVERTS

- It is a waterway enclosure used to pass water from one point to another
  - Embankments
  - Under a road section
  - Cross Drainage
  - Ditch Relief

# **CULVERT CLASSIFICATIONS**

- There are two culvert classifications
  - Permanent
  - Expediant

# PERMANENT CULVERT

- Corrugated metal pipe  
(CMP)



# PERMANENT CULVERT

- Concrete pipe (CP)



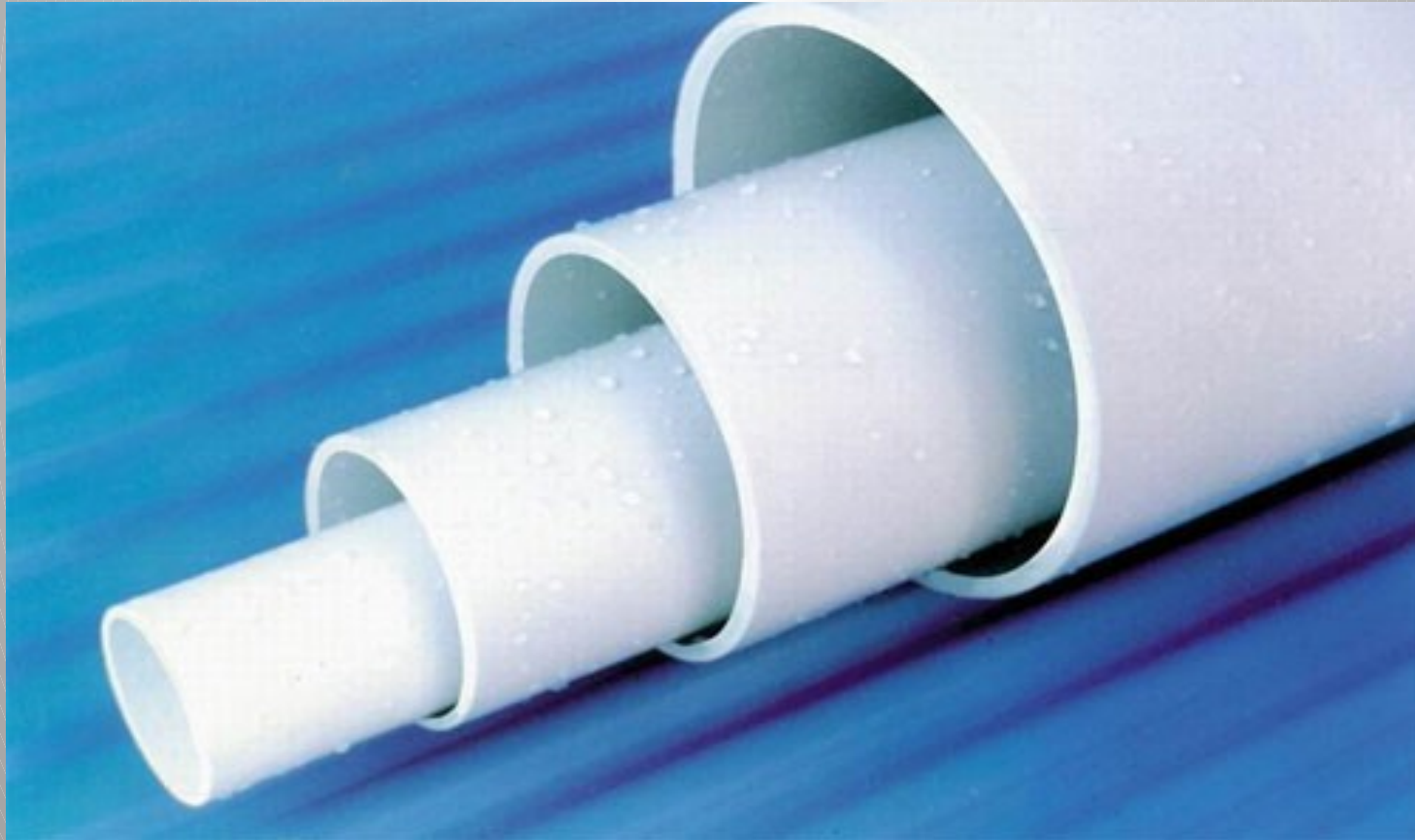
# PERMANENT CULVERT

- Vitrified clay pipe (VC)



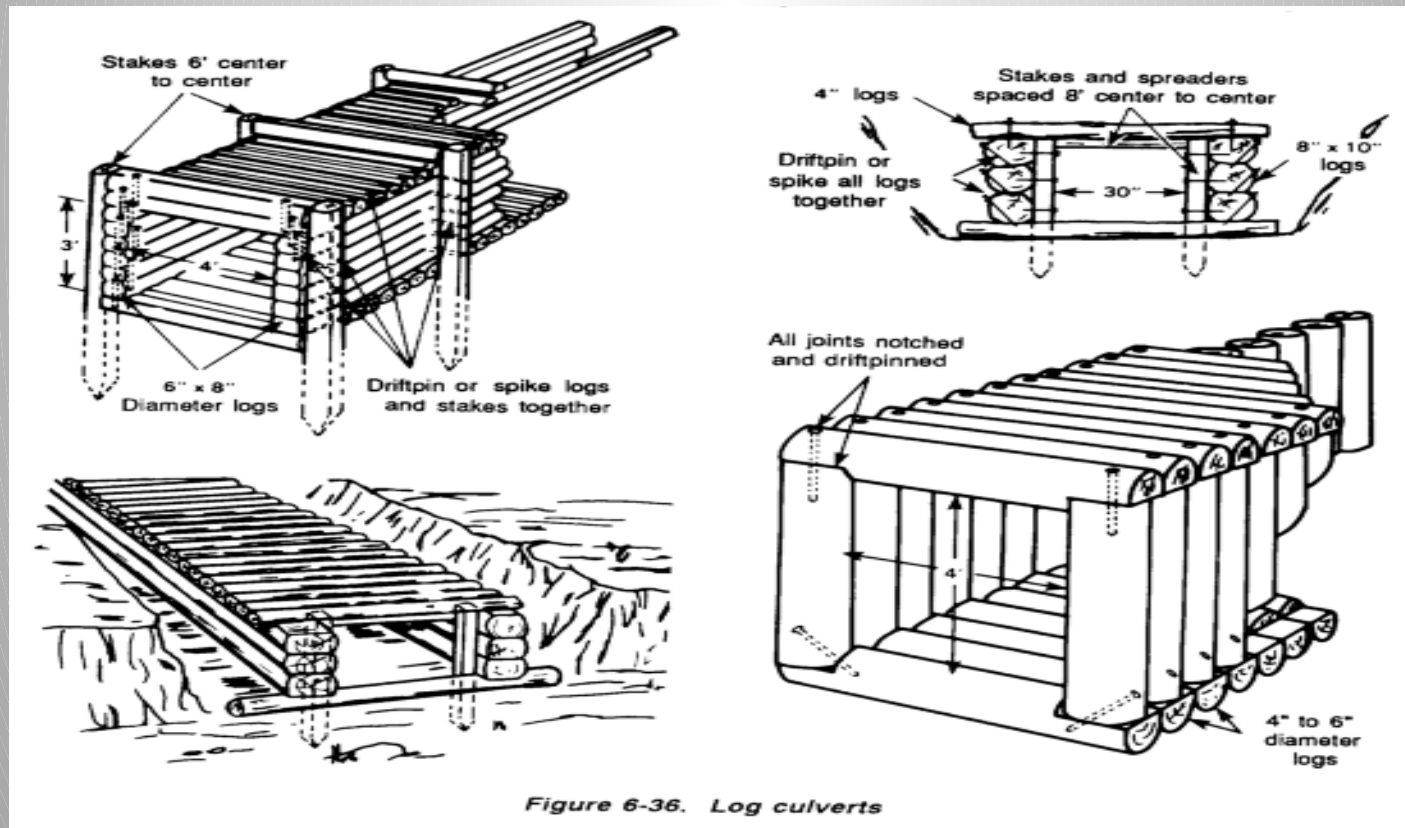
# PERMANENT CULVERT

- Polyvinyl Chloride Pipe (PVC)



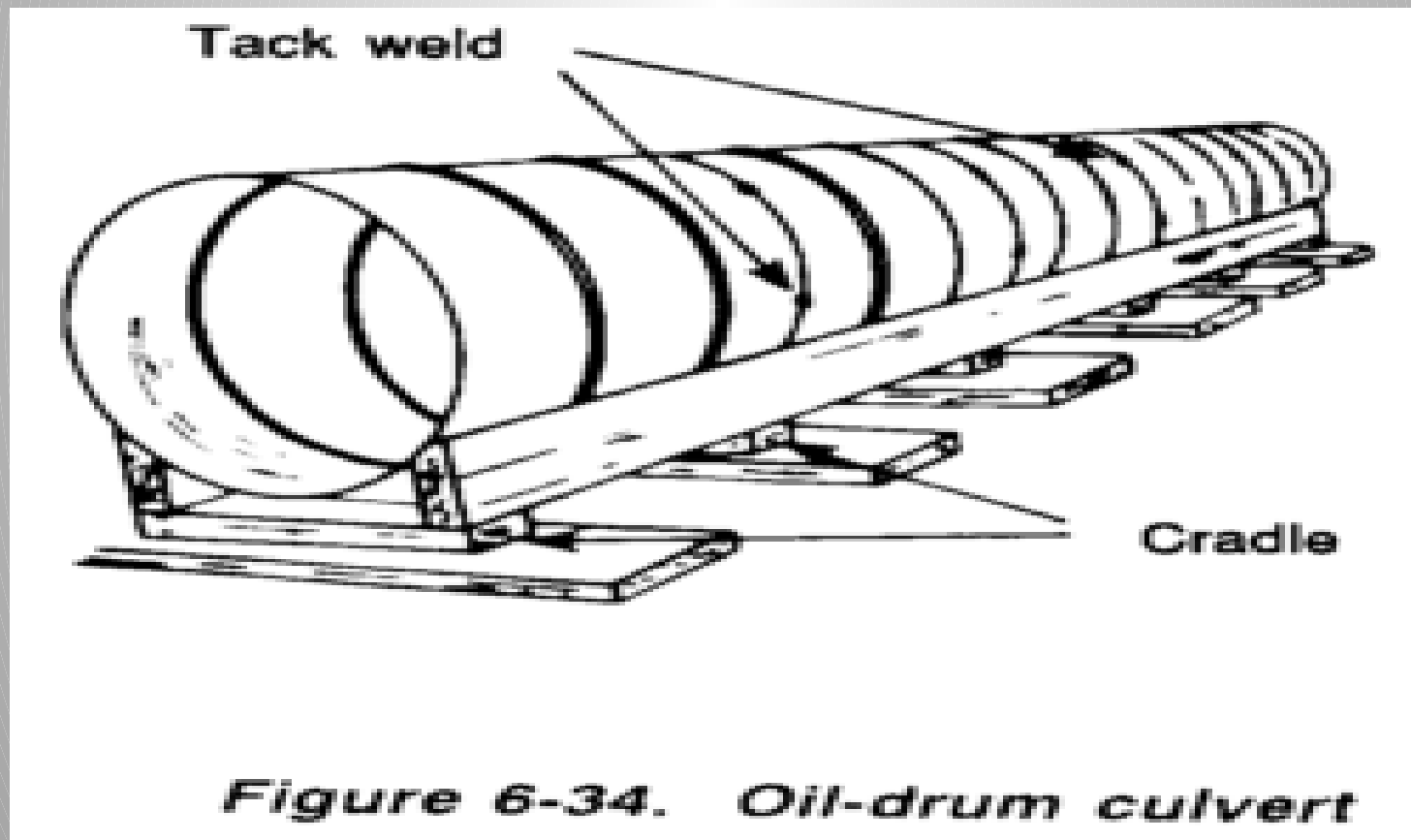
# EXPEDIENT CULVERTS

- Logs and Lumber (wooden)



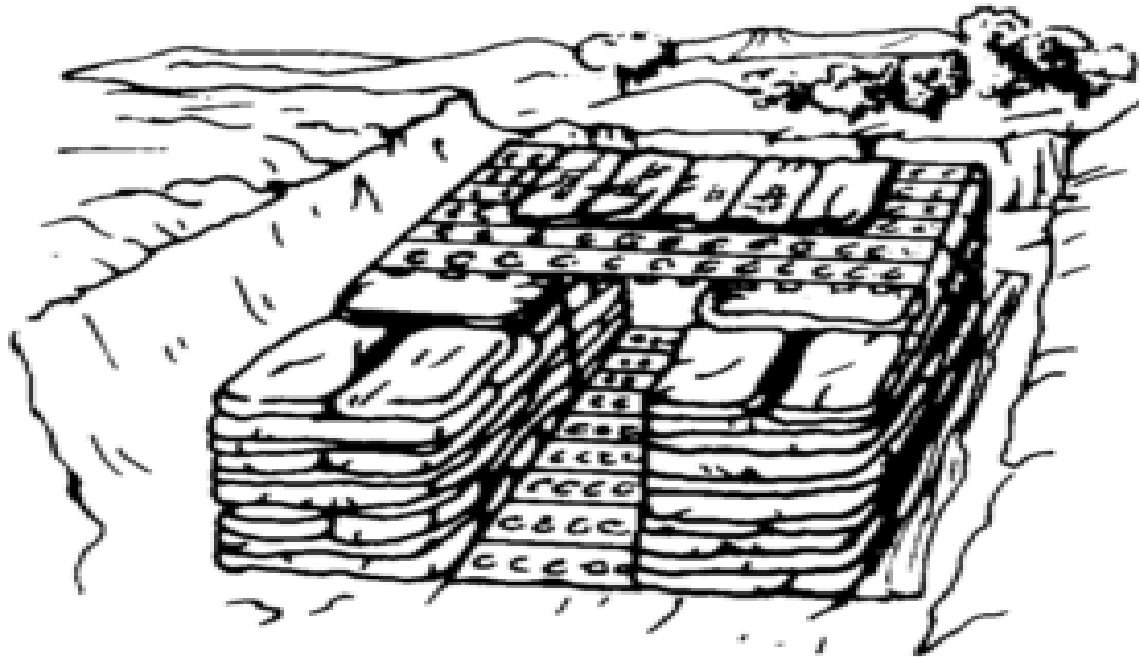
# EXPEDIENT CULVERTS

- Oil Drums



# EXPEDIENT CULVERTS

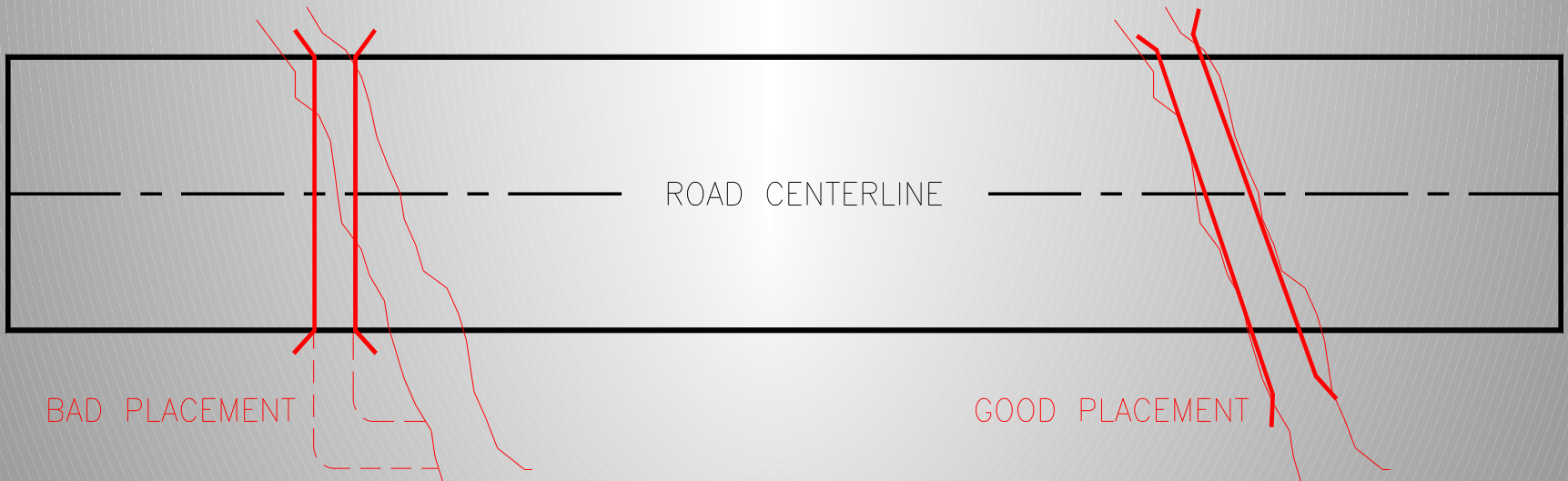
- Landing Mat and Sand bags



*Figure 6-35. Landing-mat and sandbag culvert*

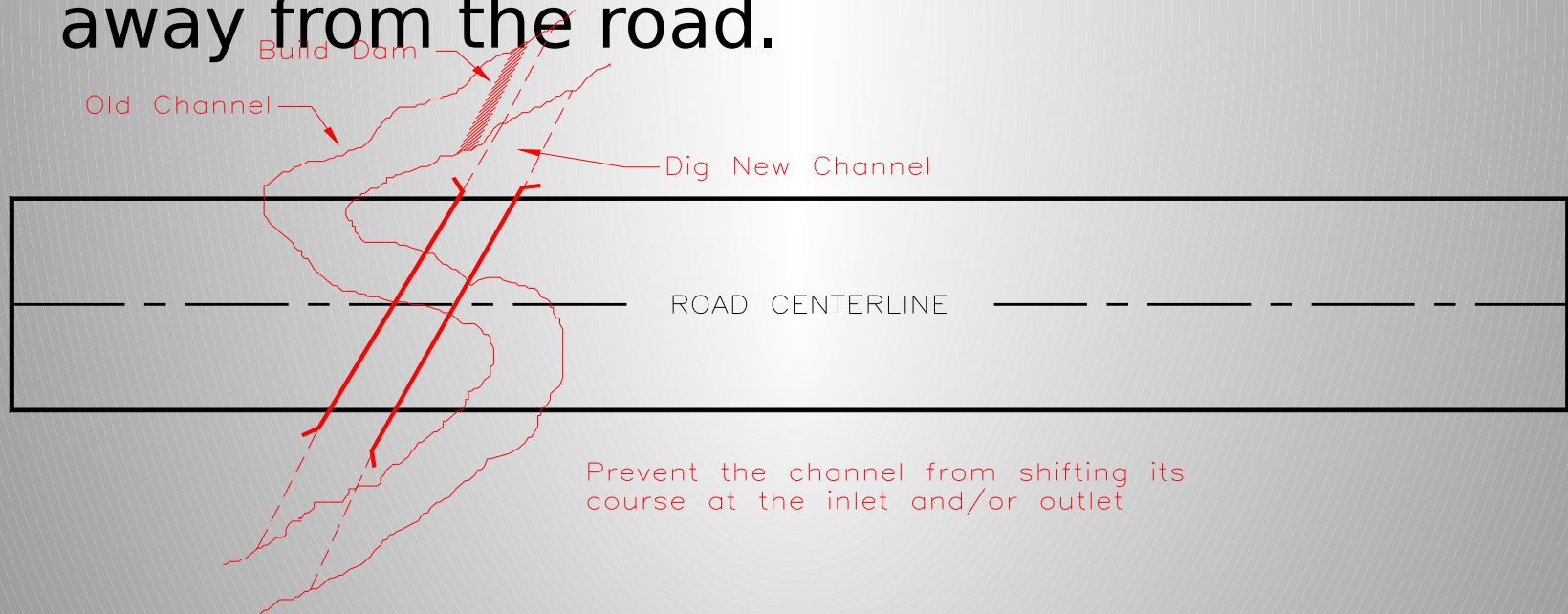
# CULVERT ALIGNMENT

- To maintain an existing drainage path, place the culvert directly in the channel bottom. If no change is made to the original path of the existing channel, the drainage will not change its direction.



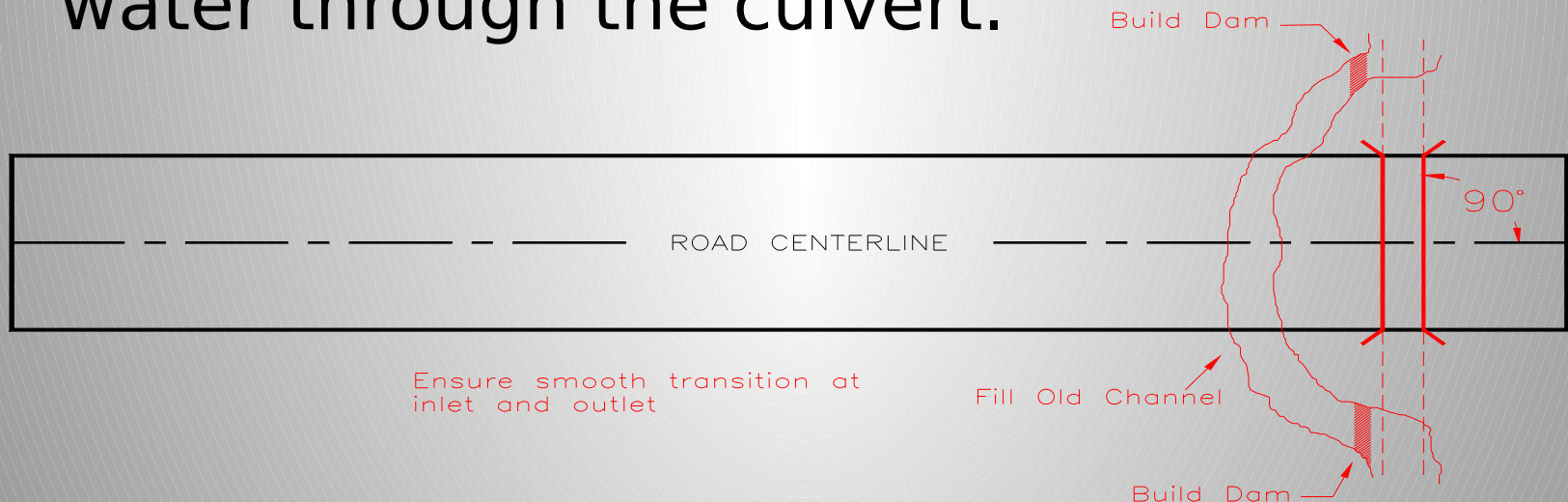
# CULVERT ALIGNMENT

- Sometimes the road must be constructed on a section where the channel meanders. In this case it is a good idea to cut a new path that will direct the existing channel away from the road.



# CULVERT ALIGNMENT

- The road may also cut across a bend in the channel. Place the culvert at a 90 degree angle to the road, and fill and compact the bend of the channel. Place a dam at the inlet and outlet to redirect the flow of water through the culvert.



# QUESTIONS ?



# **CONSTRUCTION SURVEY**

- Is to support the construction activities for the road
- Broken down into three distinct phases
  - Preliminary
  - Final Location
  - Construction Layout

# ALIGNMENT STAKES

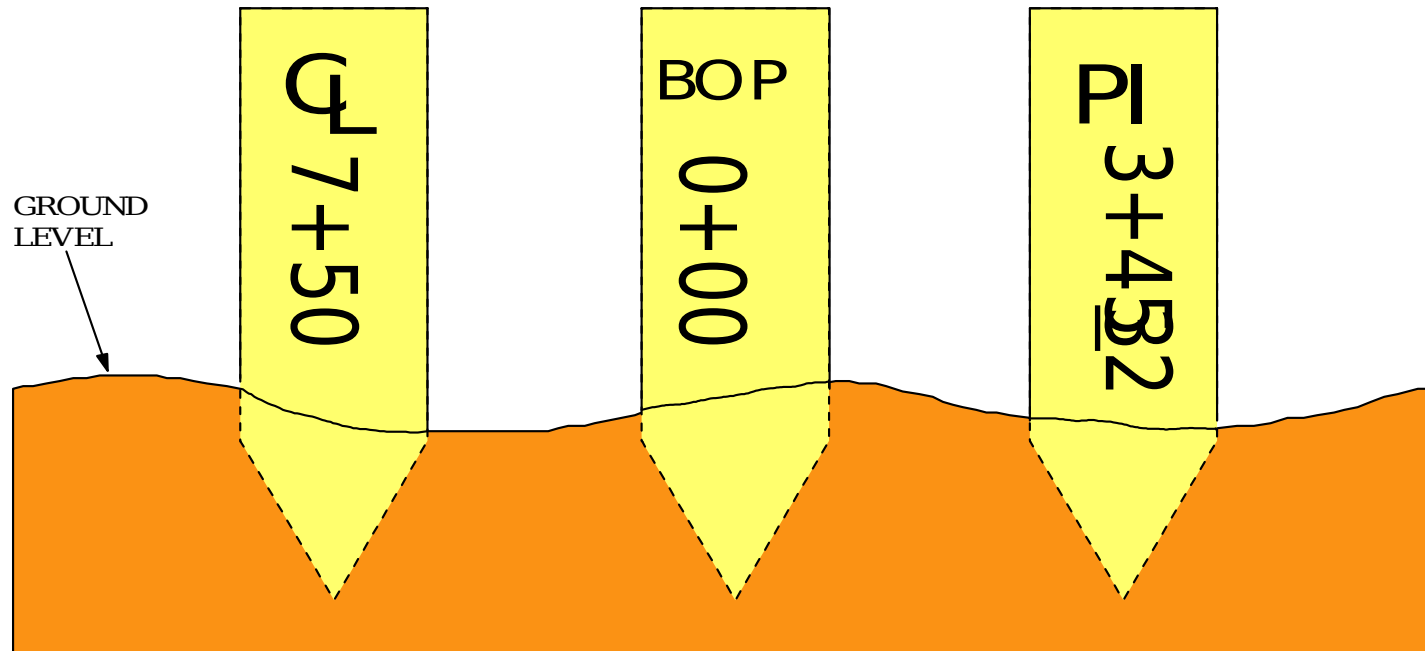
- Indicate:
  - Horizontal alignment
  - Establish sub grade
  - Establish finish grade
  - Cut and Fill
  - Side Slope ratios

# CENTERLINE STAKES

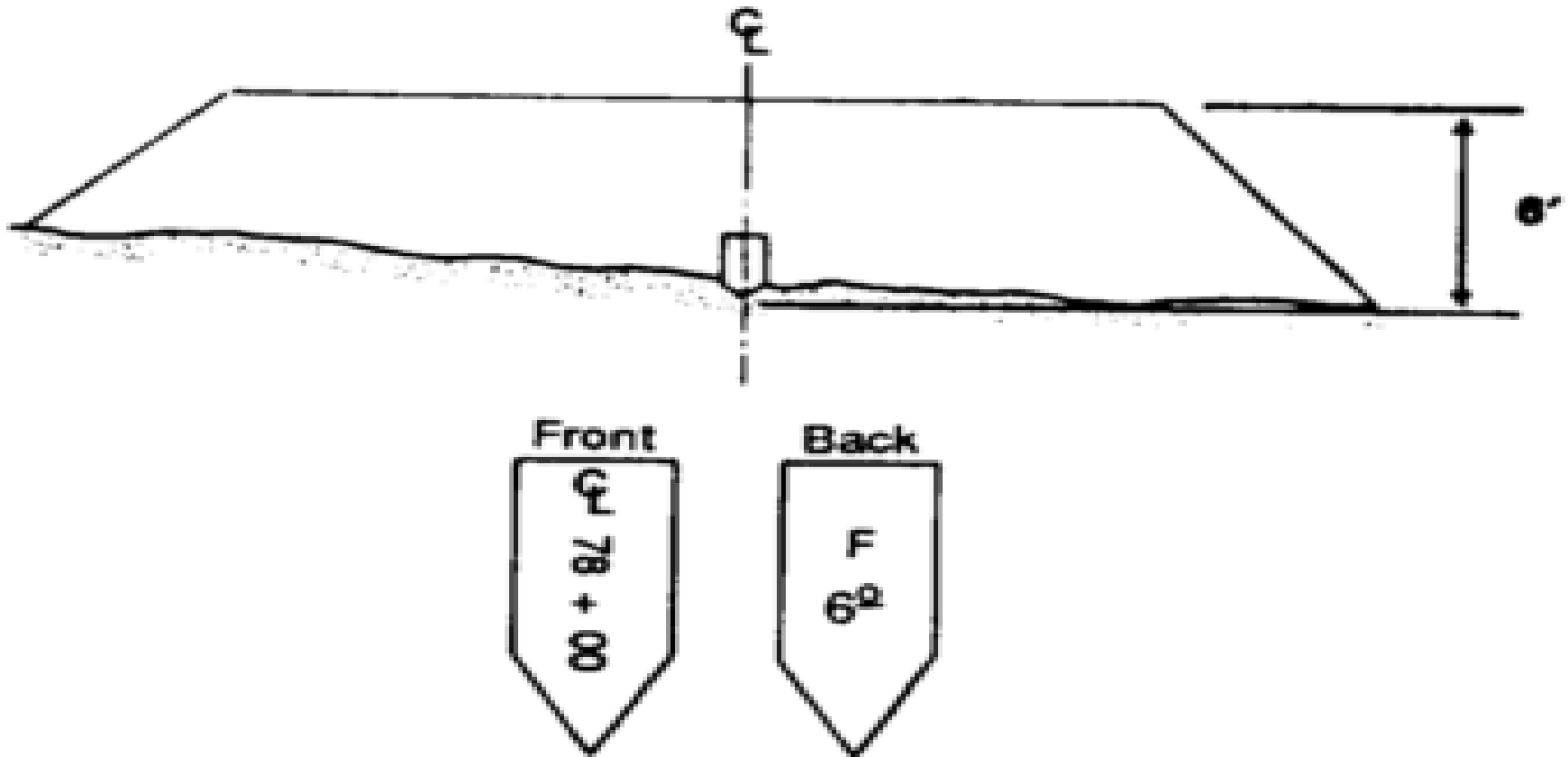
- These stakes establish the location of the road centerline (CL).
- They are normally set at 100 foot station intervals starting at the beginning of the project (BOP), and proceeding to the end of project (EOP).
- They are marked with station values on the front of the stake which faces in the direction of the BOP.

# CENTERLINE STAKES

## CENTERLINE STAKES FACES BOP



# CENTERLINE STAKES



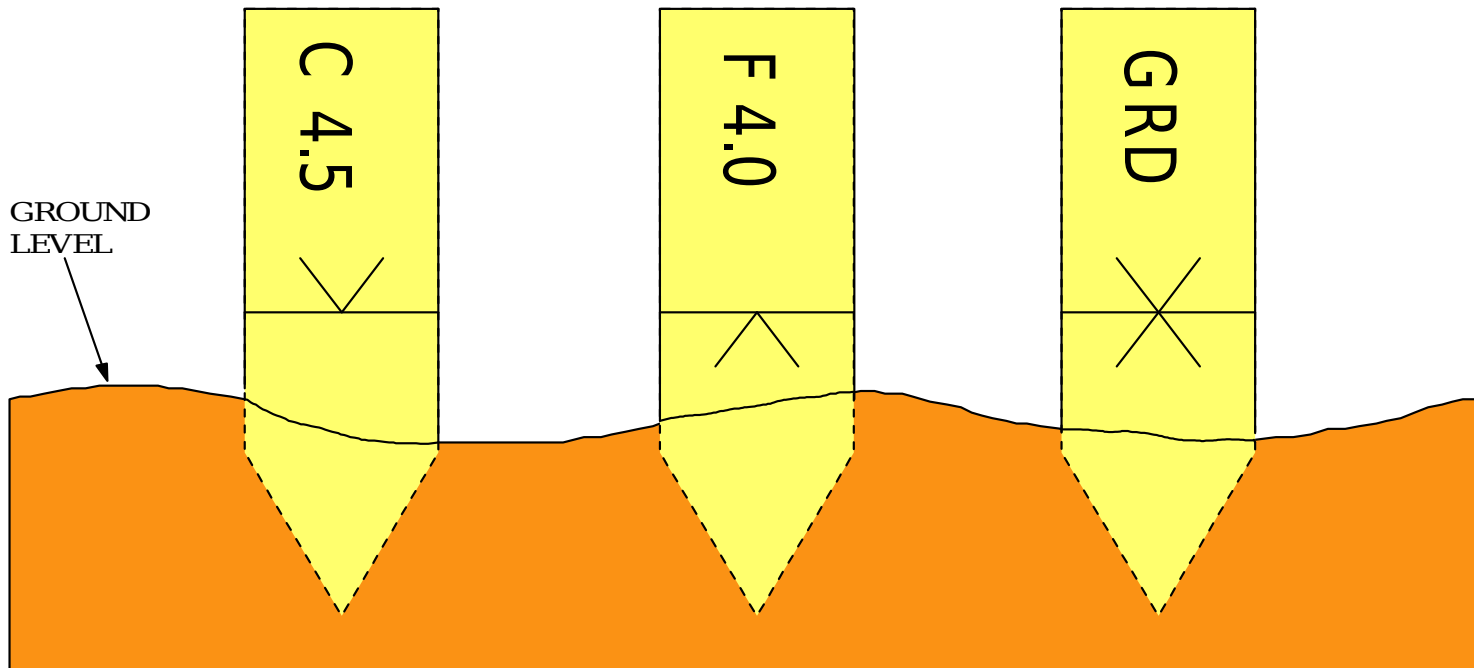
*Figure 3-1. Centerline stakes*

# GRADE STAKES

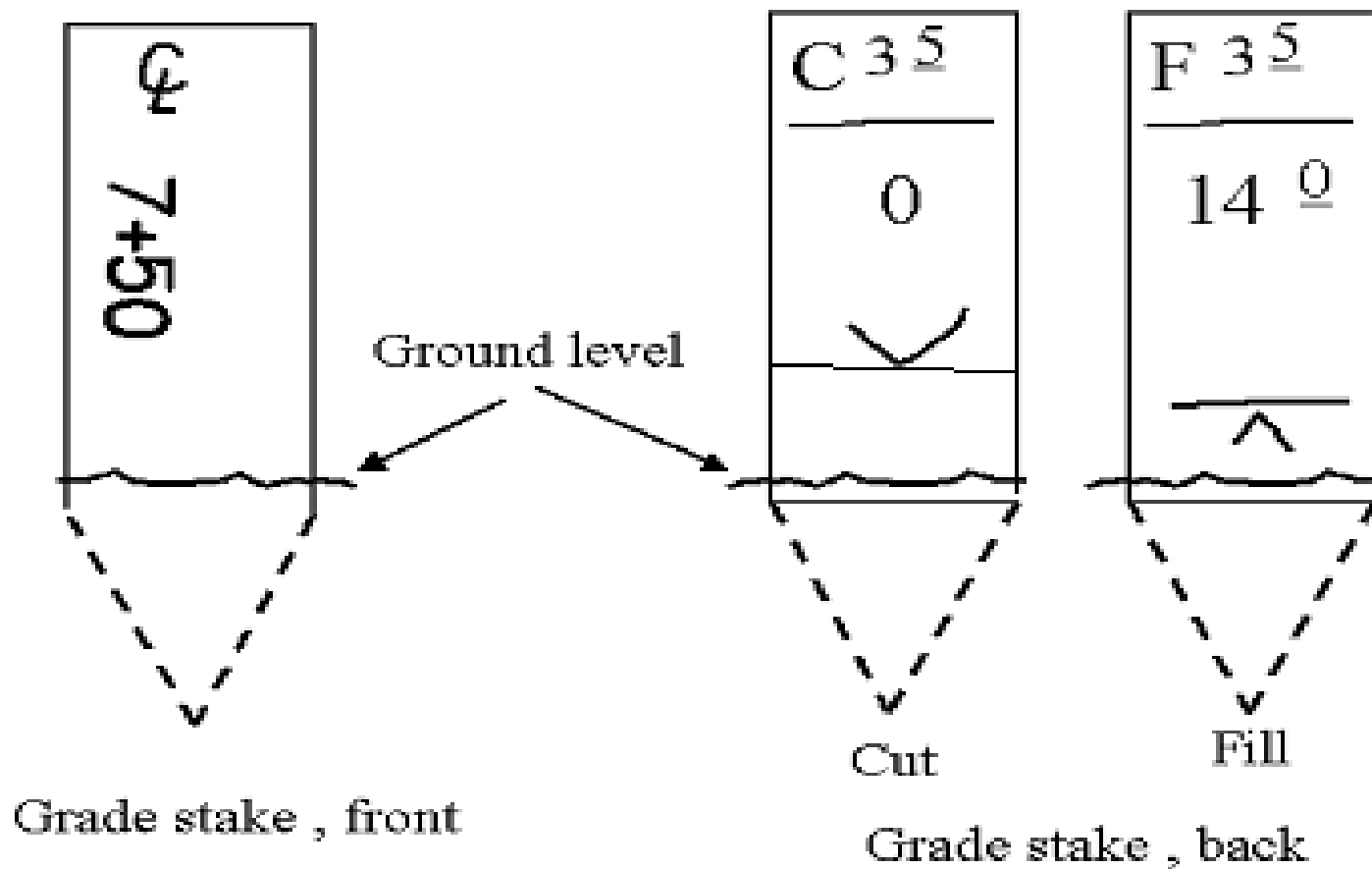
- These stakes guide grading operations during the establishment of the vertical alignment (sub-grade and finish grade) for a road.
- They will indicate the amount of earth that must be cut or filled at each station along the road centerline.
- The back of the centerline stake will be marked with the cut or fill amounts, and will be shown to the nearest half of a foot.

# GRADE STAKES

## GRADE STAKES BACK OF CENTERLINE STAKE FACING EOP



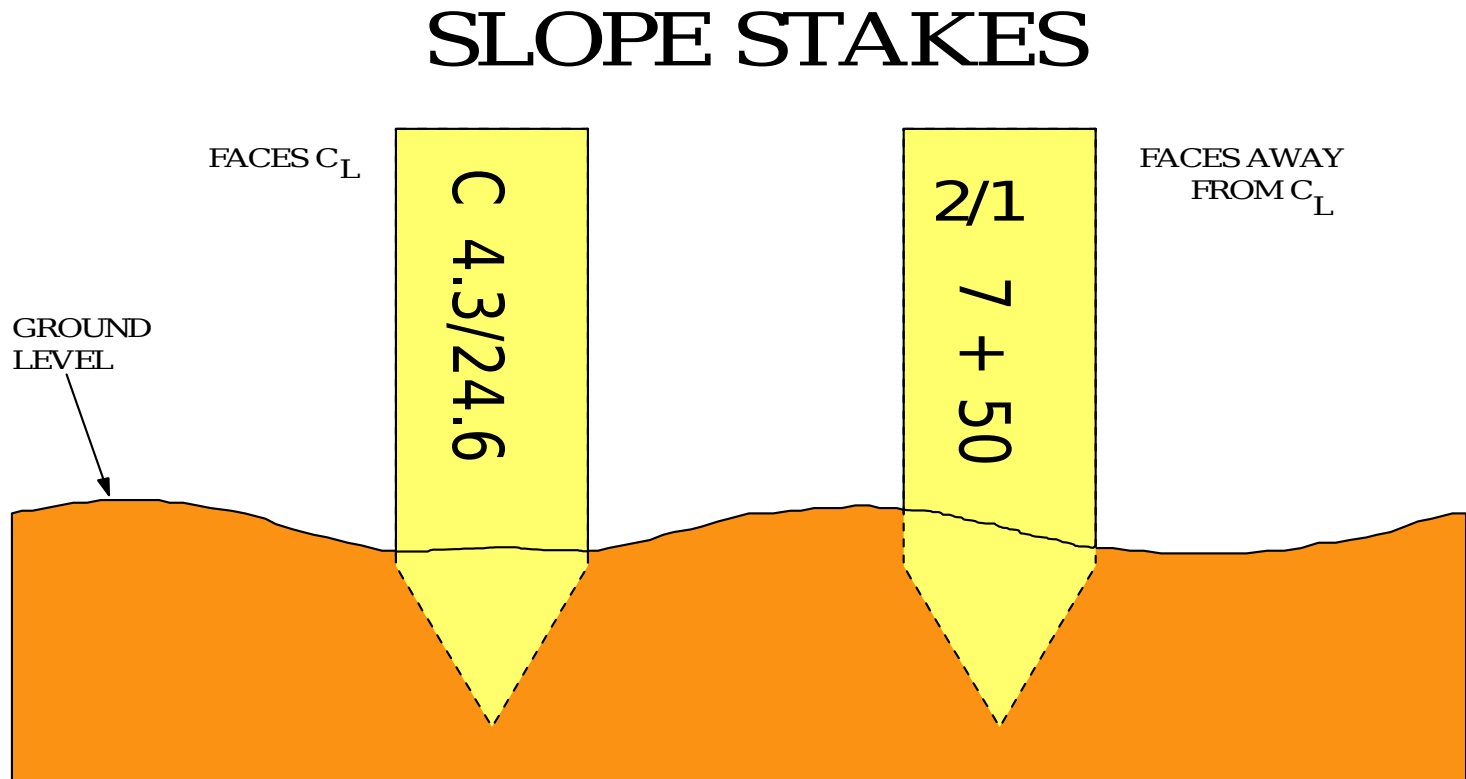
# GRADE STAKES



# SLOPE STAKES

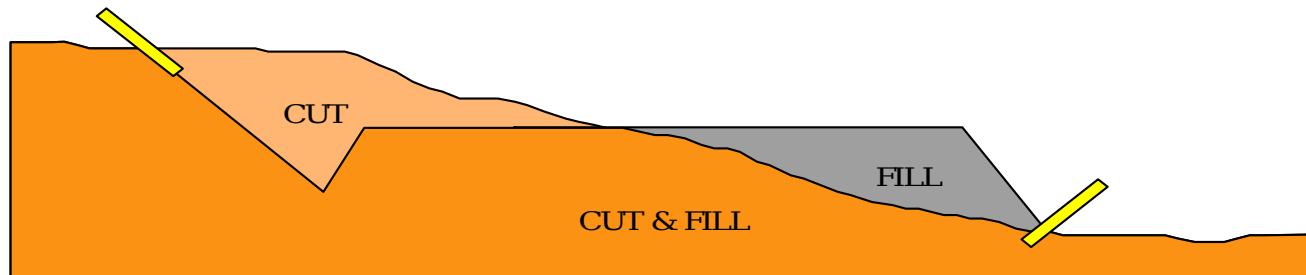
- These stakes establish the earth moving limits, left and right of the centerline.
- Slope stakes are placed at the left and right limits of the roadway facing the centerline at a 45 degree angle.
- They identify the top of cut on the back slope of a ditch, or the toe of fill on an embankment.
- They are marked with the slope ratio and station value on the back of the stake, and are marked with the cut or fill value and distance from the centerline on the front of the stake.

# SLOPE STAKES



# SLOPE STAKES

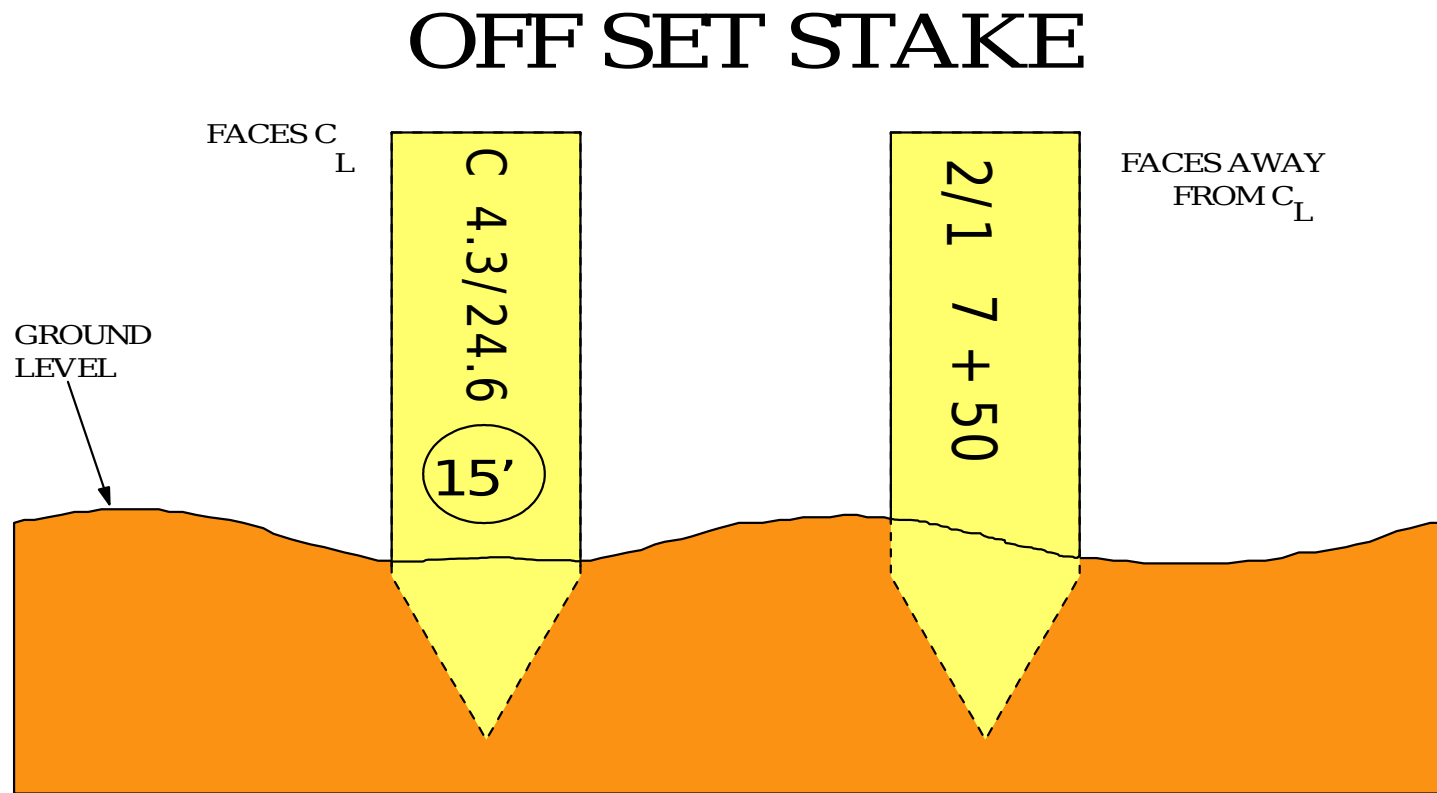
## SLOPE STAKE PLACEMENT



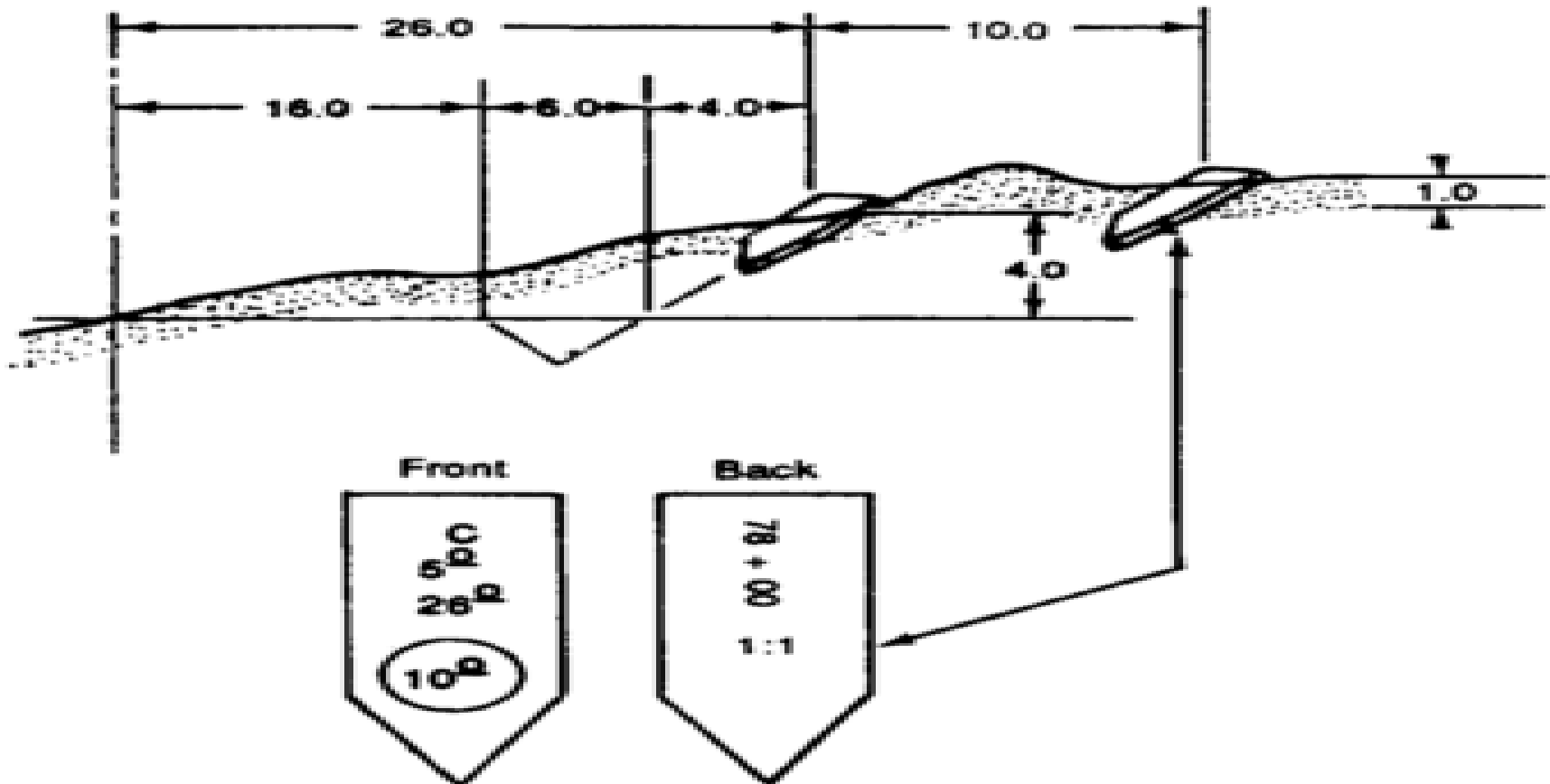
# OFFSET STAKES

- Offset stakes are placed as references out beyond the slope stakes at key stations.
- They are used as a backup reference for the surveyors to reestablish critical alignment stakes that may have been disturbed during earth moving operations.
  - Reference the BOP station.
  - ▮ Reference the EOP station.
  - ▮ Reference curve stations and culvert locations.

# OFFSET STAKES



# OFFSET STAKES



**Figure 3-3. Marking and placement of offset stakes**

# QUESTIONS?



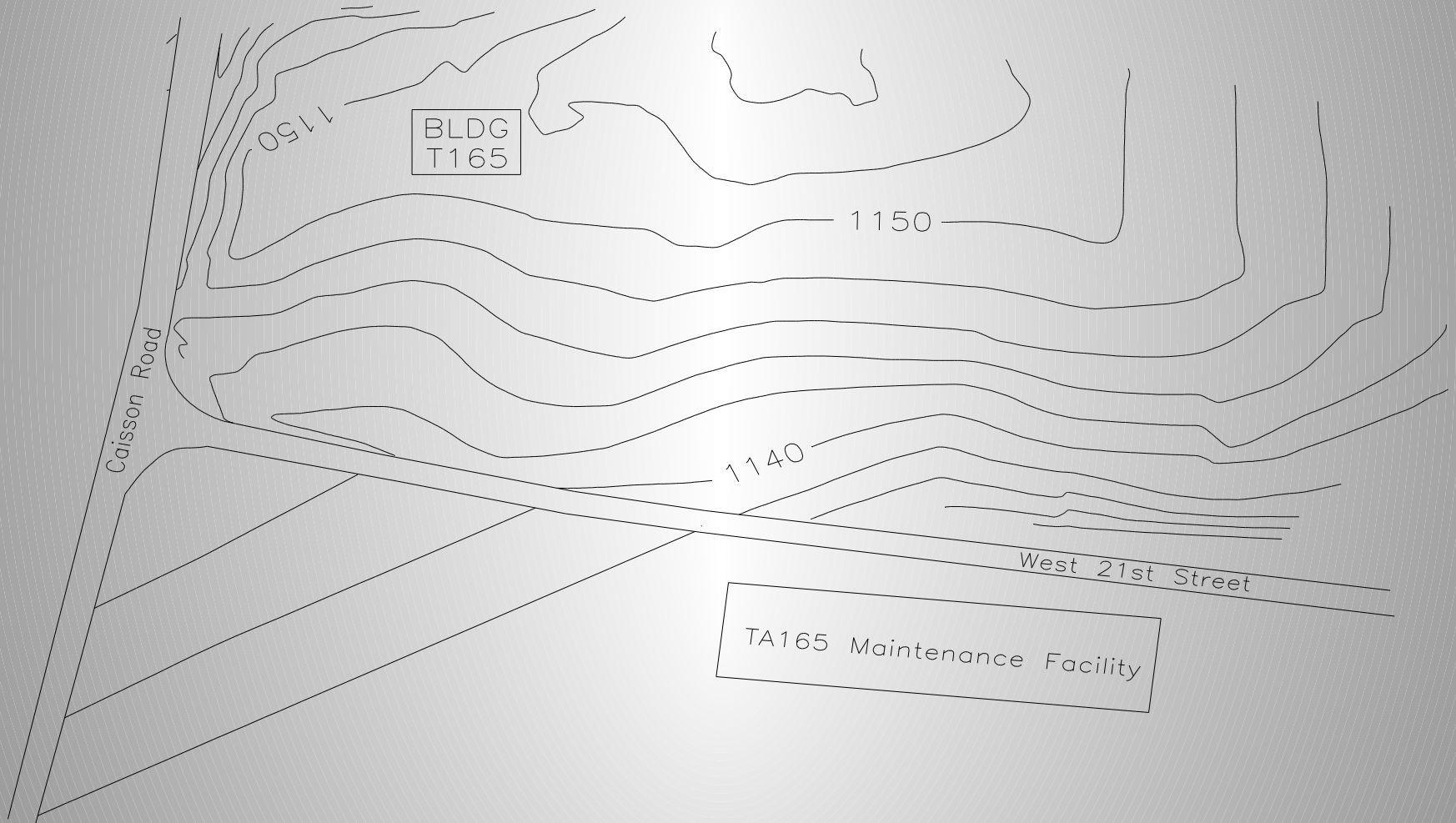
# CONSTRUCTION PLANS

- Finished drawings are used in the development of all military roads.
- Construction plans provide layout information to the Engineer Assistants.
- These plans are critical to the Engineer Equipment Chief as a tool to supervise construction surveys and earth moving operations.

# SITE PLAN

- A site plan shows all existing manmade and natural features on the existing project site before construction begins.
- This drawing is created after the preliminary survey has been conducted.
- Terrain relief is shown by contour lines placed at two or five foot contour intervals to show to clearly show the topographic relief of the intended road route

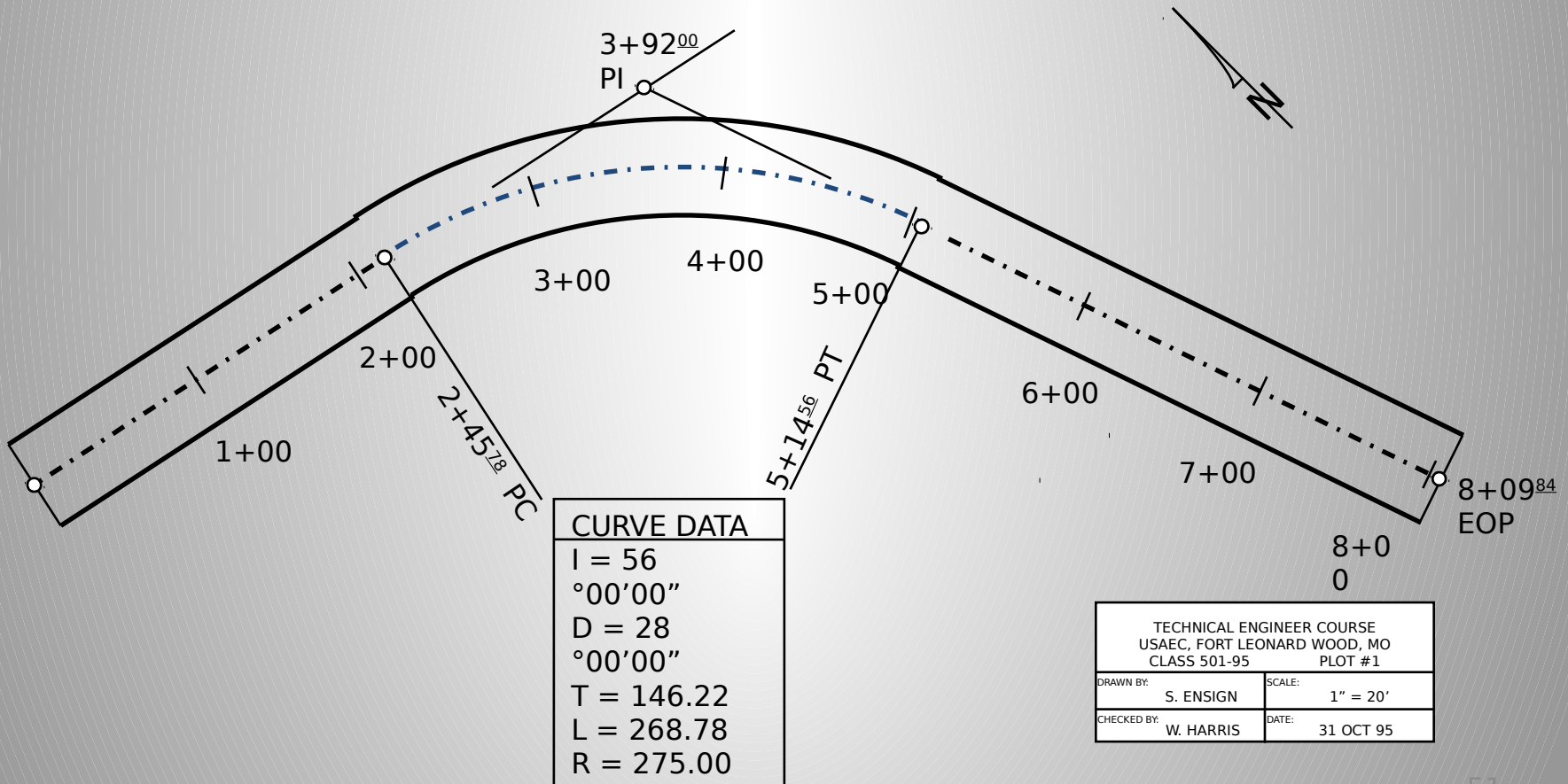
# SITE PLAN



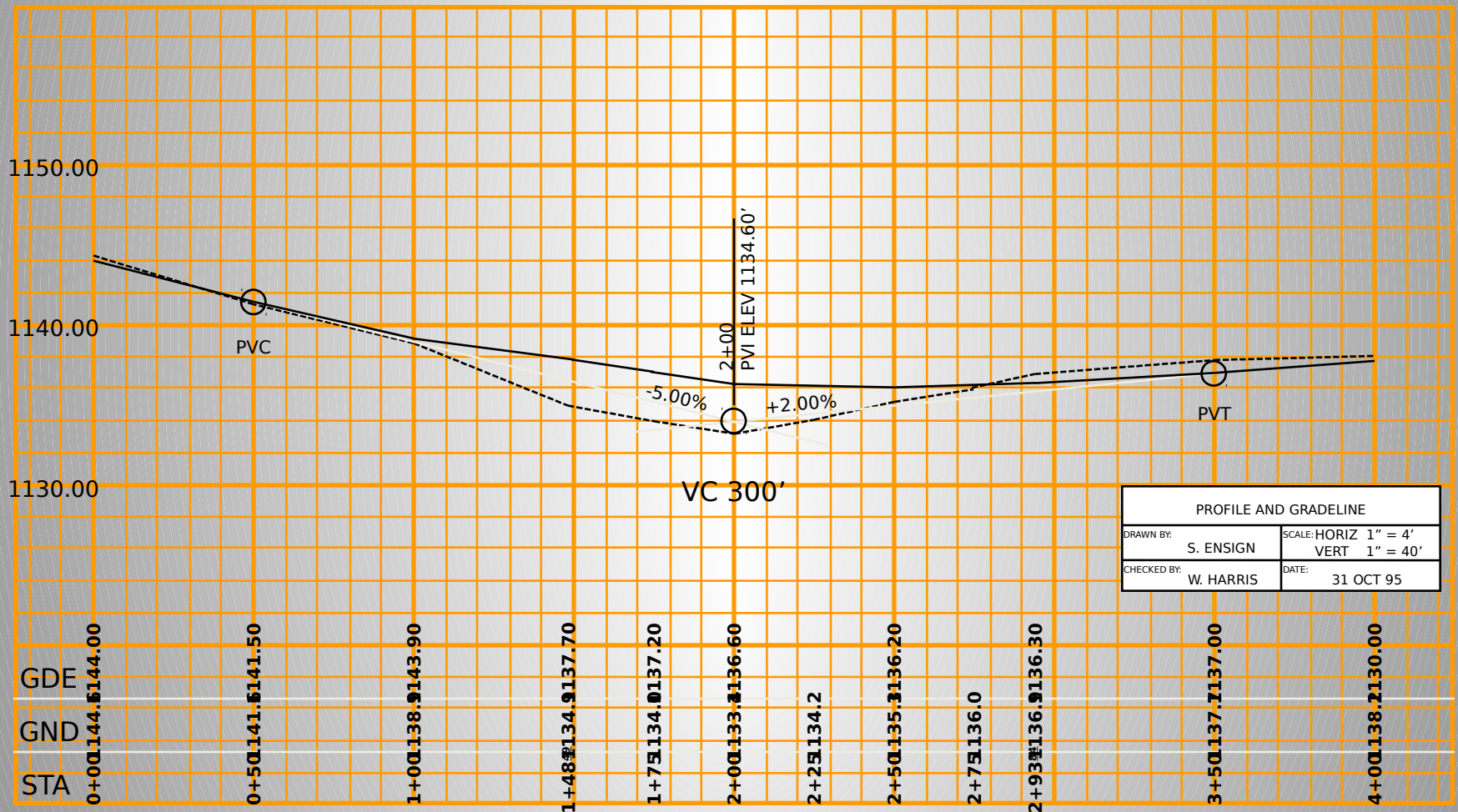
# PLAN AND PROFILE DRAWING

- The plan view is a "Top View" looking down on the road.
- This is the primary drawing used for the location and layout of the road, showing all horizontal alignment information for staking the centerline of the road, and culvert locations.
- The profile is a sectional view taken along the centerline of the road, and shows the existing ground elevations and proposed grade line elevations.

# PLAN DRAWING

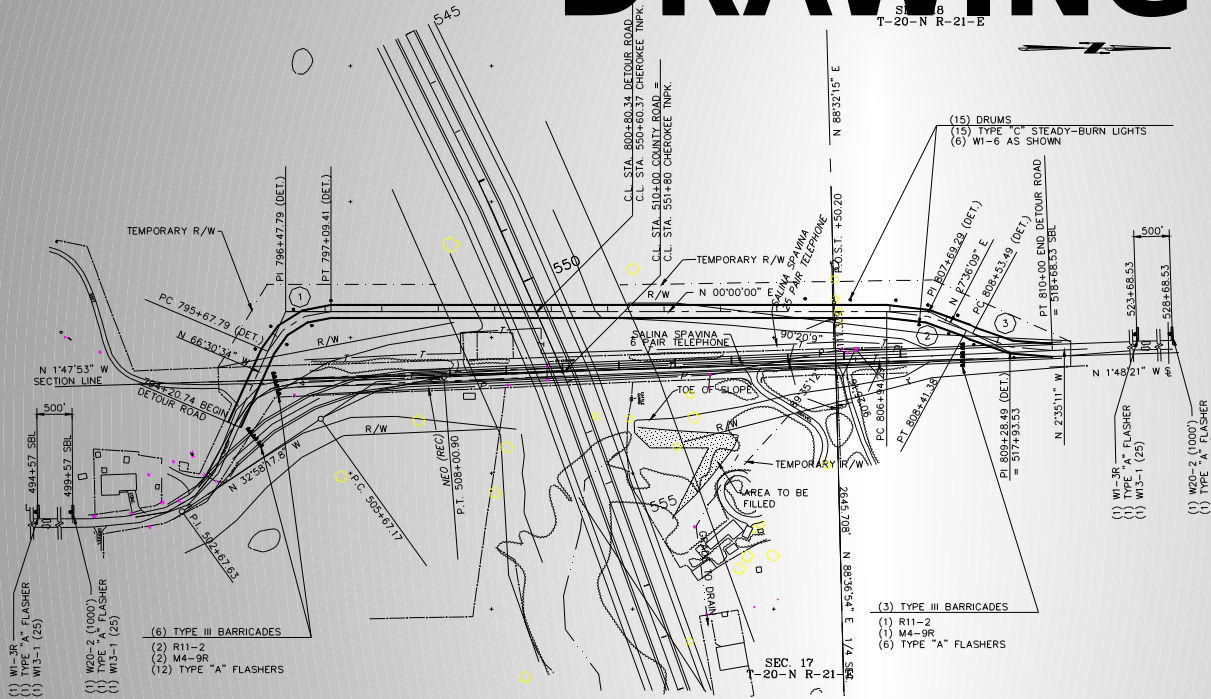


# PROFILE DRAWING

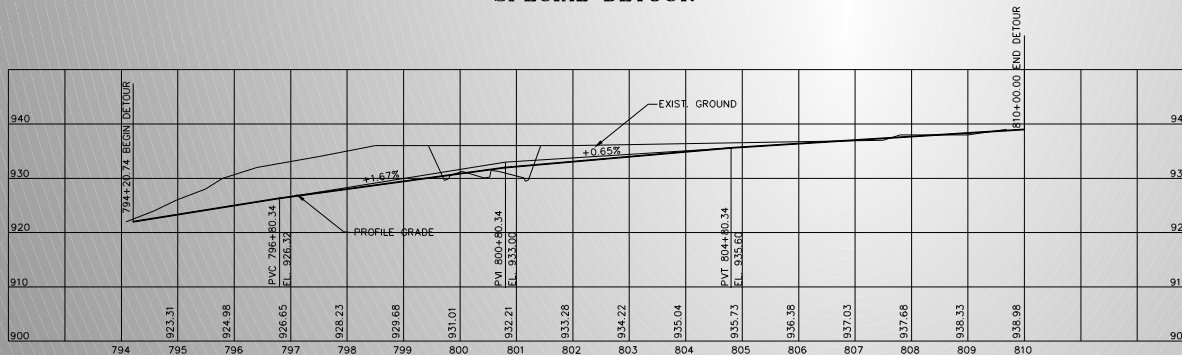


# PLAN AND PROFILE DRAWING

ST 8  
T-20-N R-21-E



SHOO-FLY & CONSTRUCTION SIGNING AT CROSS STREET - STA. 551+80  
SPECIAL DETOUR



OKLAHOMA TURNPIKE AUTHORITY				
SECTION ENGINEER	SECTION	CONTRACT NUMBER	SHEET NO.	TOTAL SHEETS

#1 DETOUR CURVE DATA	#2 DETOUR CURVE DATA	#3 DETOUR CURVE DATA
PI STA. 796+47.81	PI STA. 807+69.32	PI STA. 809+28.49
$\Delta = 66.30.34$	$\Delta = 27.36.09$	$\Delta = 30.11.20$
$D = 46.57.49$	$D = 18.46.12$	$D = 20.36.17$
$T = 80$	$T = 75$	$T = 75$
$L = 141.62$	$L = 147.09$	$L = 146.51$
$R = 122.0$	$R = 305.25$	$R = 278.07$
$E = 23.89$	$E = 9.07$	$E = 9.94$

ROUTE	POINT	STATION	COORDINATES	
			NORTH	EAST
Q	BASE LINE	P.I.	502+67.63	452555.90 2855805.56
Q	BASE LINE	P.C.	505+67.16	453207.20 2855642.55
Q	BASE LINE	P.I.	506+86.85	453307.61 2855577.41
Q	BASE LINE	P.T.	508+00.90	453427.17 2855572.01
Q	BASE LINE	P.T.	510+00.00	453626.07 2855563.02
Q	BASE LINE	P.T.	516+50.00	454275.41 2855533.69
Q	BASE LINE	P.O.T.	519+00.00	454264.13 2855783.44
DETOUR @ STA 551+80				
Q	DETOUR	P.O.T.	794+20.74	453044.48 2855659.62
Q	DETOUR	P.C.	795+67.79	453103.09 2855524.75
Q	DETOUR	P.I.	796+47.79	453134.98 2855451.38
Q	DETOUR	P.T.	797+09.41	453214.98 2855451.38
Q	DETOUR	P.C.	806+94.29	454199.87 2855451.38
Q	DETOUR	P.I.	807+69.29	454274.87 2855451.38
Q	DETOUR	P.T.	808+41.38	454341.30 2855486.12
Q	DETOUR	P.C.	808+53.49	454352.03 2855491.73
Q	DETOUR	P.I.	809+28.49	454418.50 2855526.48
Q	DETOUR	P.C.	810+00.00	454493.42 2855523.09

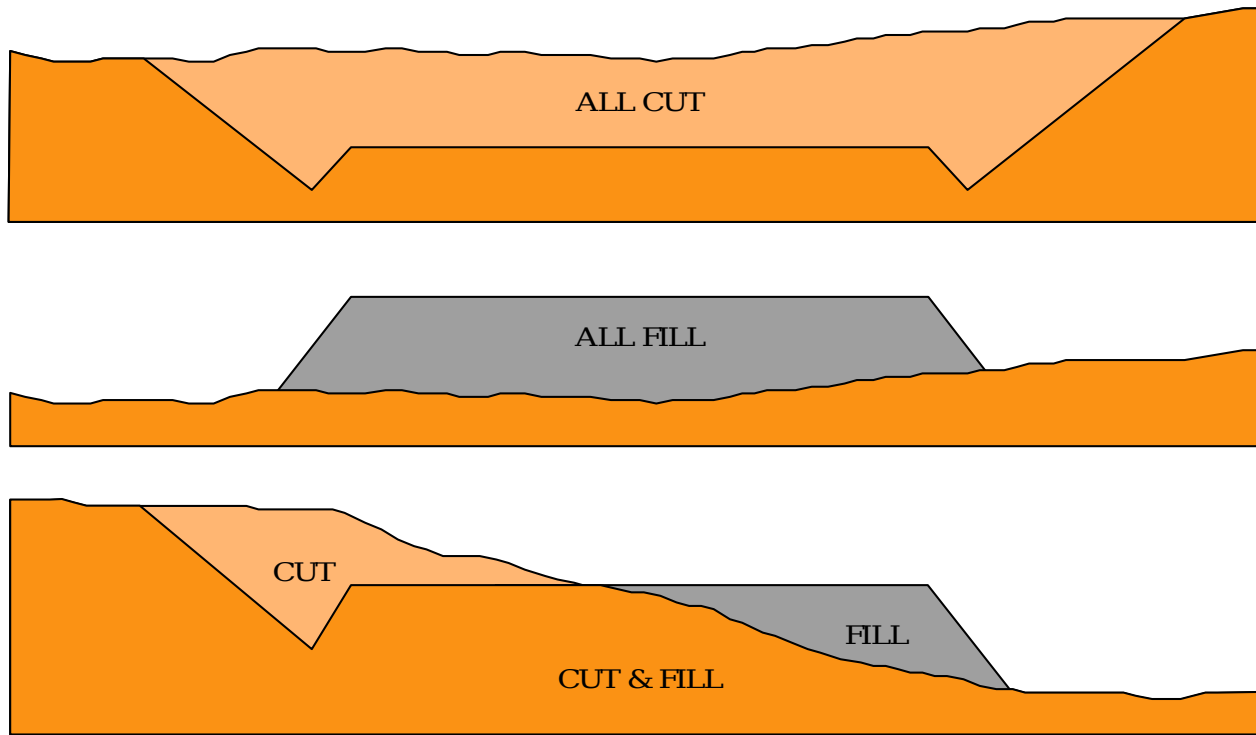
NO.	REVISION	BY	DATE
OKLAHOMA TURNPIKE AUTHORITY CHEROKEE TURNPIKE			
SPECIAL DETOUR SHT. #3			
THE BREISCH COMPANY INC. ENGINEERING ARCHITECTS PLANNERS SAND SPRING, OKLAHOMA 74063			
CONTRACT NO.			
DESIGNED	LWB		
DRAWN	WAR		
CHECKED	LWB		
DATE	AUG. 11, 1989	SHEET	OF

# CROSS SECTION DRAWING

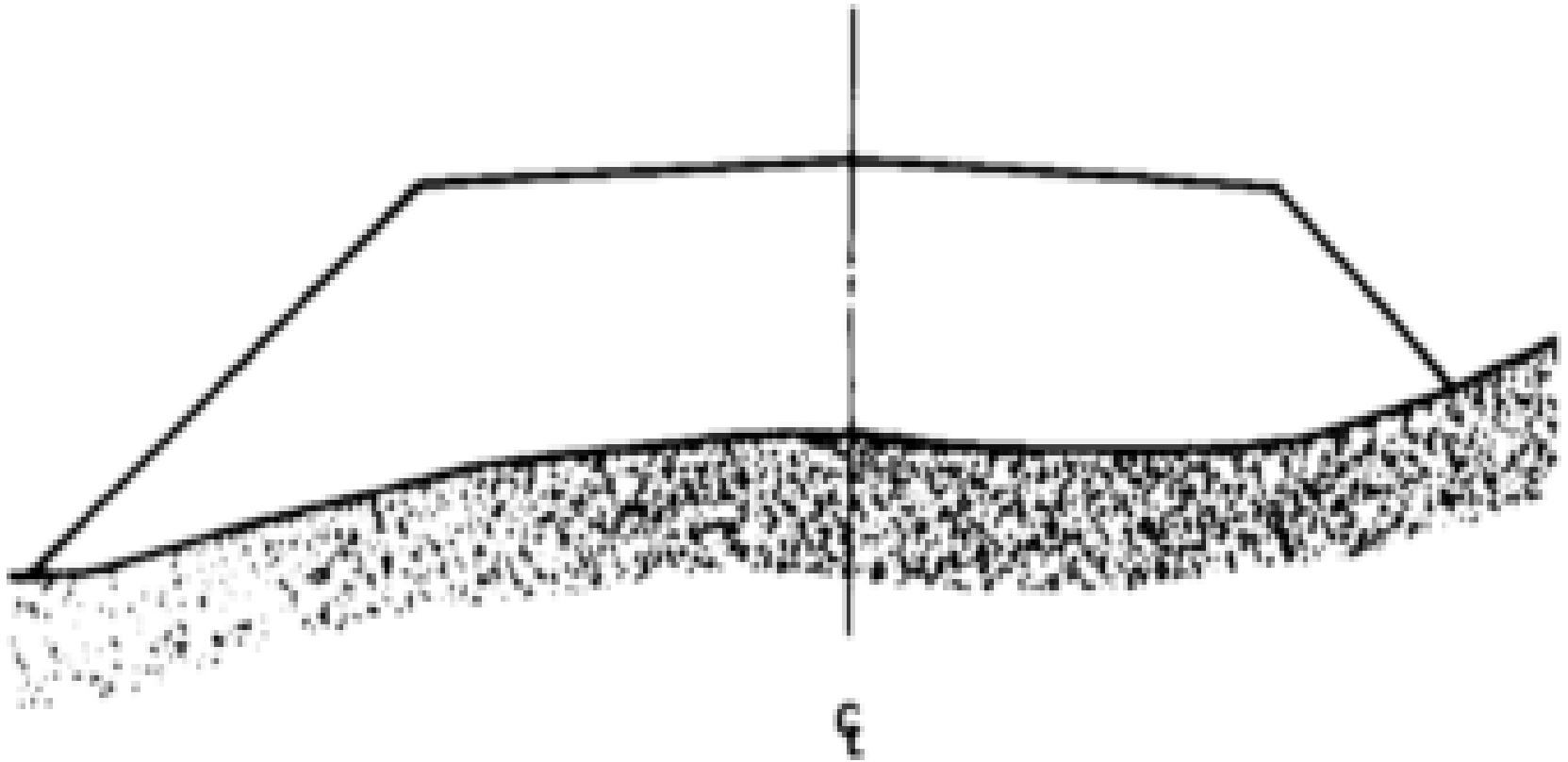
- The cross section is a section view of the road, cut perpendicular to the centerline, looking in the direction of travel. There are two types of cross section drawings:
  - **Earthwork Cross Sections:** These drawings show the existing ground line and proposed road grade line. These are the primary drawings that are used to generate earthwork volume estimations.
  - ▯ **Typical Cross Section:** This drawing will show the road dimensions, slope ratios, and types of materials to be used to construct the proposed road.

# EARTH CROSS SECTION

## EARTHWORK SECTIONS



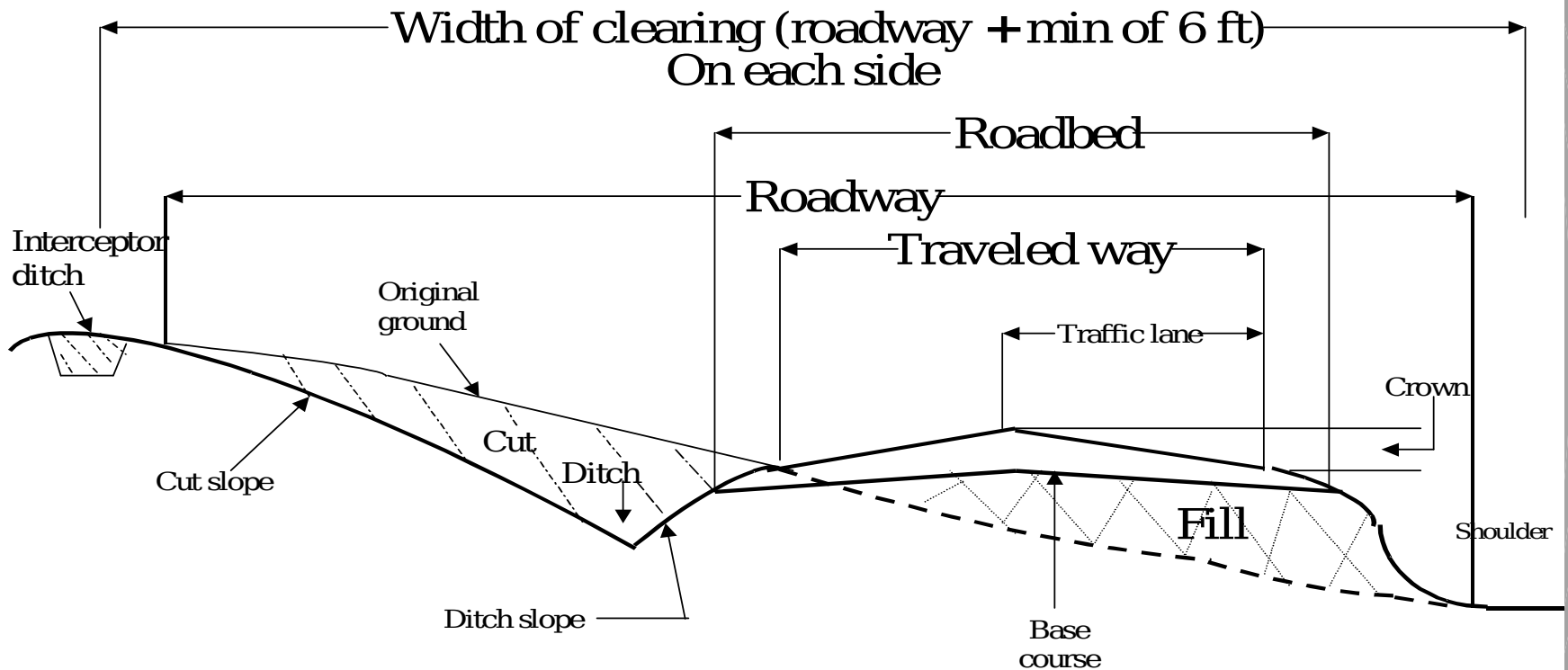
# EARTH CROSS SECTION



*Figure 3-4. Typical fill cross section*



# TYPICAL CROSS SECTION

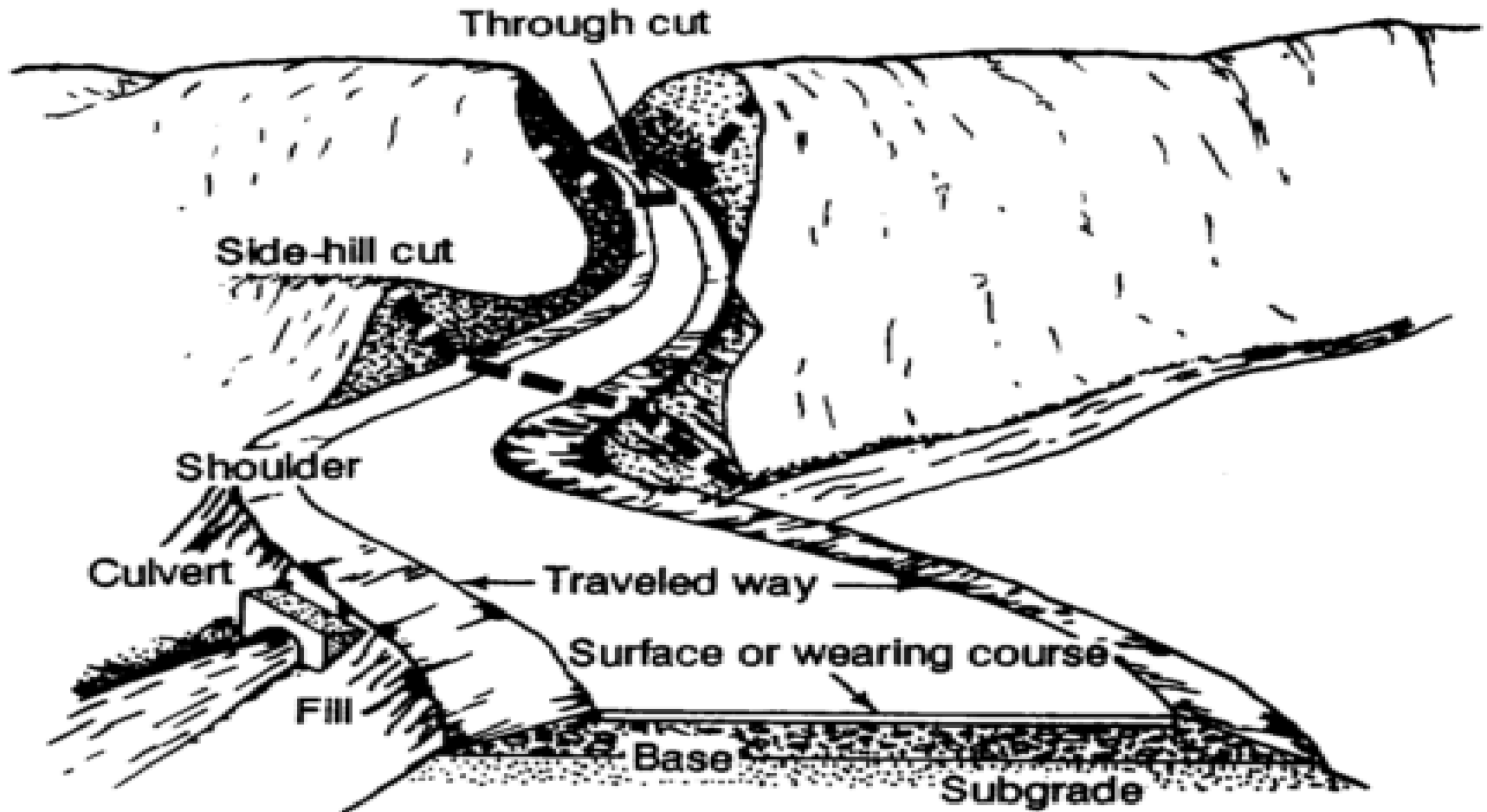


**Road cross section and nomenclature**

# QUESTIONS?



# ROAD DESIGN

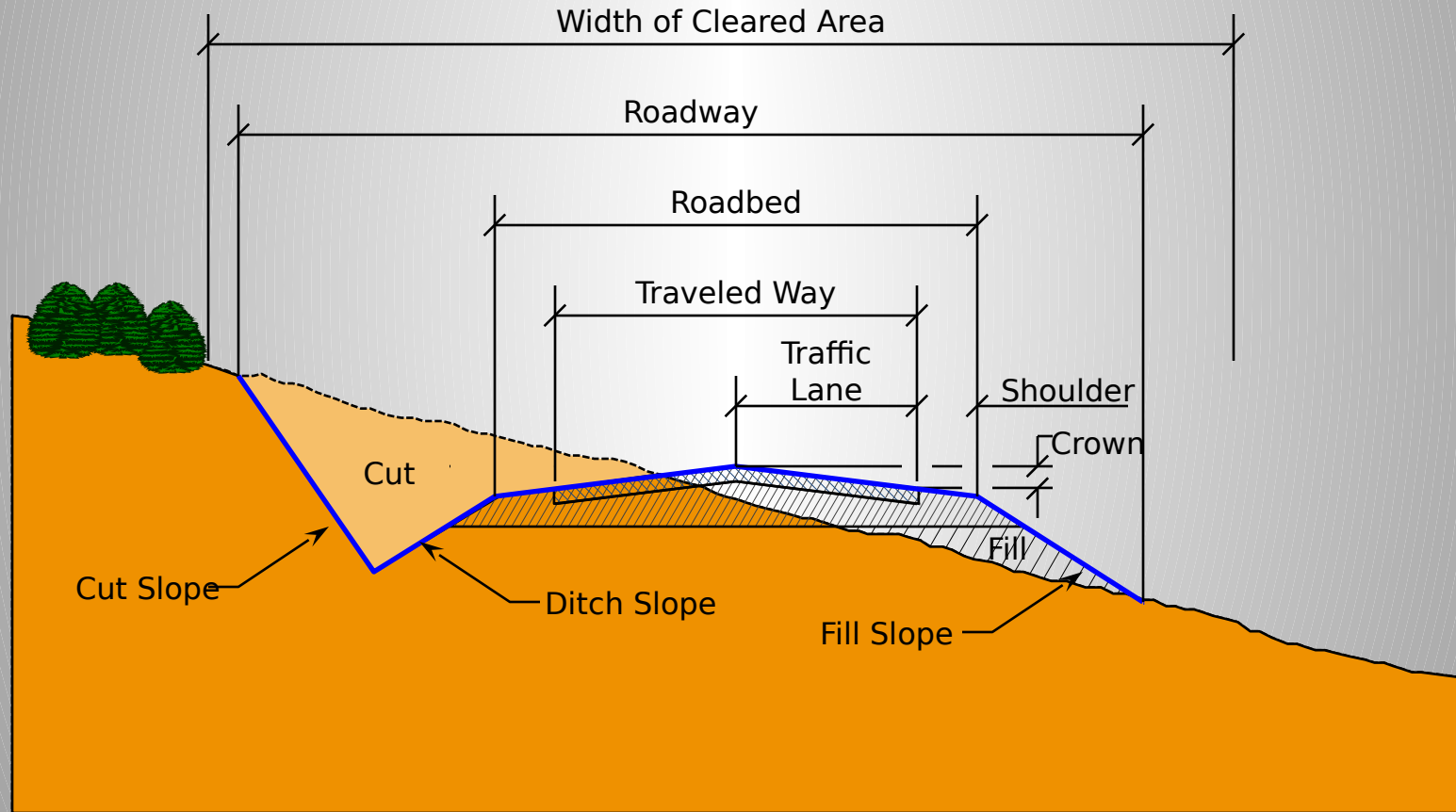


*Figure 9-1. Road nomenclature*

# ROAD DESIGN

- Road design will be dependant upon several factors
  - Subgrade
  - Anticipated Traffic
  - Drainage conditions
  - Construction time available
  - Materials and Equipment available
  - Personnel and Expertise available

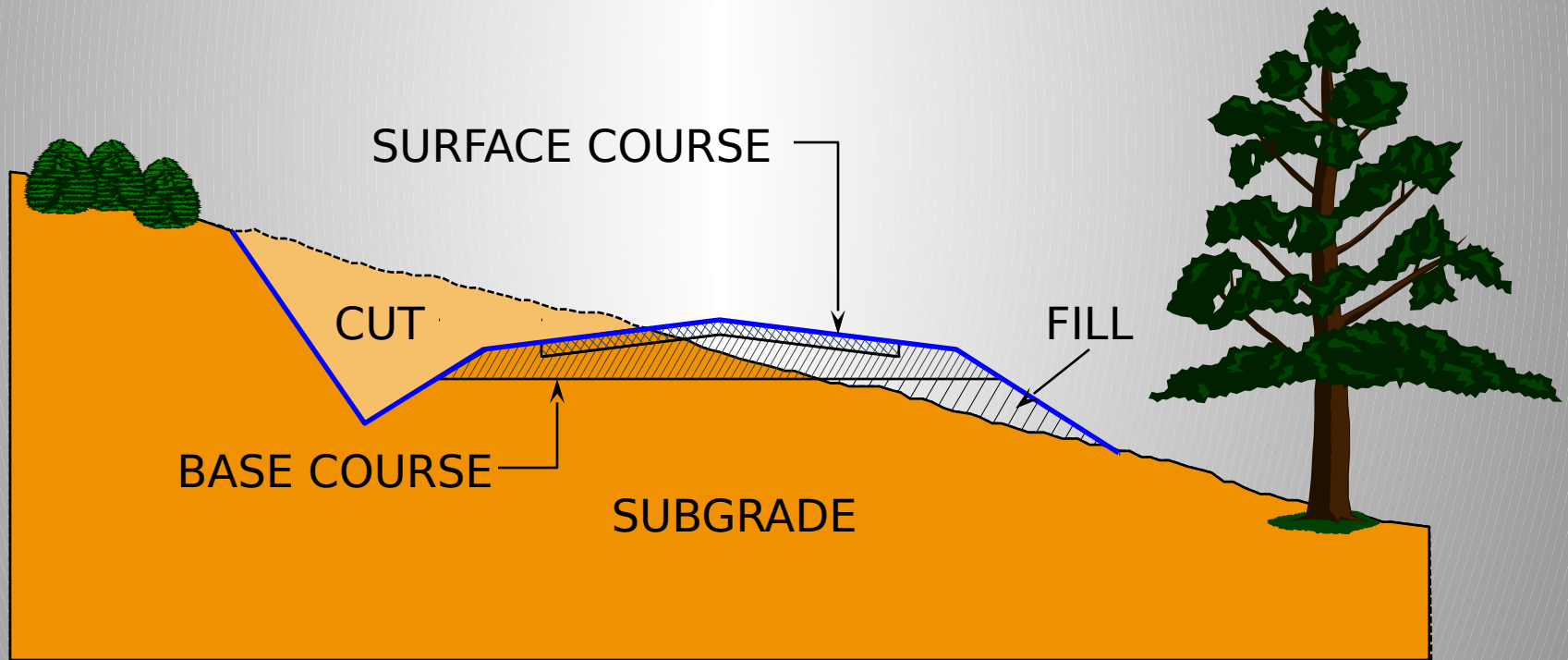
# ROAD COMPONENTS (FYI)



# **SUB GRADE**

- The roads foundation
- Distributes the load to the earth below
- Most usually constructed with existing (Indigenous) material

# ROAD COURSES (FYI)



# BASE COURSE

- Distributes the loads (traffic) to the subgrade
- Must be strong enough so that the transferred load will not exceed the subgrade strength

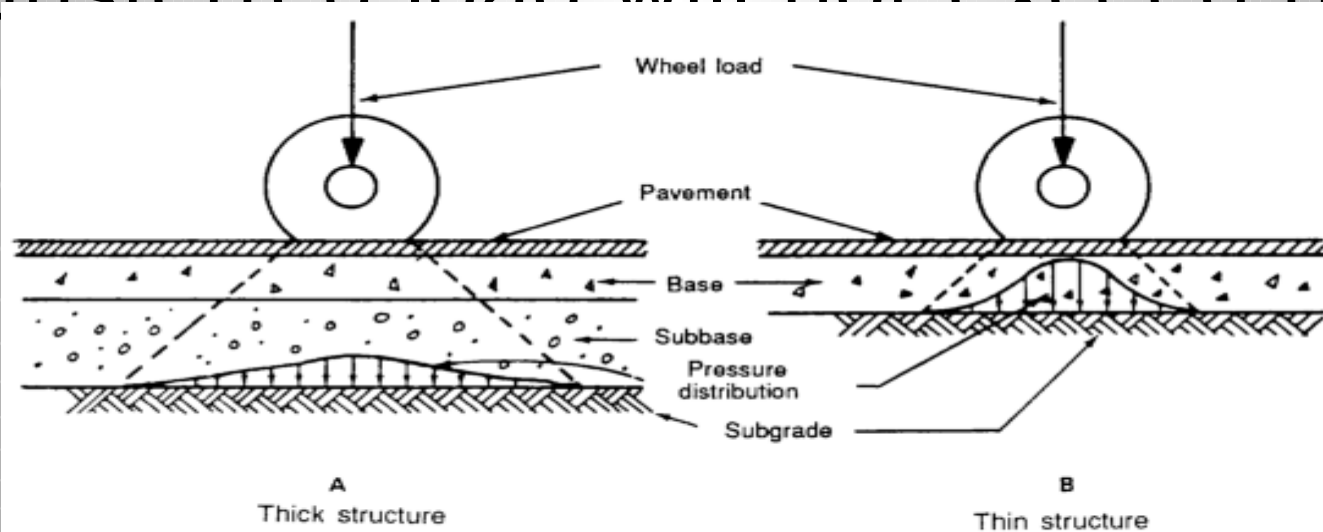


Figure 5-2. Distribution of pressures under single-wheel loads

# GEOMETRIC DESIGN

- Based on road class
- Ensures safety and good traffic flow
- Begins with a good topo survey
  - Identify centerline
  - Calculate grades and vertical curves
    - Refer to table 9-1
  - Calculate degree and length of horizontal curves
    - Refer to table 9-1

# GEOMETRIC DESIGN

- Adjust horizontal and vertical curves and grades
- Draw typical cross sections
- Design drainage

# ROAD TYPE

- Structural characteristics should accommodate traffic volumes.
- FM 5-430-00-1, table 9-1, show four possible road types (classes).
- Classes A and B are considered permanent.
- Classes C and D are temporary.
  - As Marine Engineers we will only construct types C and D Roads.

# TABLE 9-1

Table 9-1. Geometric design data for military roads

Design Controls and Elements		Class A (4 Lane)	Class B (2 Lane)	Class C (2 Lane)	Class D (1 Lane)	Remarks:
Design Controls						
1. Traffic composition	(1)					(1) The DHV shown for all roads is in total vehicles per hour for all lanes in both directions. The DHV is approximately 15 percent of the ADT.
Average daily traffic (ADT) (45% trucks)		3,400-6,700	935-3,400	200-935	Under 200	(2) The values shown for this term indicate the combined effects of horizontal (curves) and vertical (grade) alignment on capacity. A value of zero percent indicates an absolutely straight, flat alignment with no restriction on sight distance. A value of 100 percent indicates a road with numerous sharp curves and grade changes on which the sight distance is less than 1,500 ft(457.201 m) at any point on the road.
Design hourly volume (DHV)		510-1,000	140-510	30-140	Under 30	
Sight distance restriction, %	(2)	40-0	80-0	80-40	100	
2. Design speed (V), mph (kph)		60 (97)	60 (97)	40 (64)	30 (48)	
Average running speed, mph (kph)		45 (72)	45 (72)	35 (56)	25 (40)	
Cross-Section Elements						
3. Pavements	(3)					(3) If the anticipated traffic includes a significant number of vehicles having widths in excess of 8.5 ft (2.591 m), the traffic lanes should be widened in the amount by which the vehicle width exceeds 8.5 ft (2.591 m).
Minimum width of traffic lane, ft (m)						(4) There should be a color or texture contrast between traffic lane and shoulder surfaces.
with barrier curb		12 (3.658)	12 (3.658)	10 (3.048)	10 (3.048)	
without barrier curb		12 (3.658)	12 (3.658)	10 (3.048)	10 (3.048)	(5) Values shown are calculated on basis of maximum rate of superelevation of 0.100.
Minimum distance between curb faces, ft (m)		53 (16.154)	29 (8.839)	25 (7.620)	15 (4.572)	
Lateral clearance from edge of traffic lane to obstructions, ft (m)		6 (1.829)	6 (1.829)	6 (1.829)	4 (1.219)	
Normal cross slope (crown slope) rate		0.0104-0.0108	0.0104-0.0208	0.0208-0.0417	0.0208-0.0417	(6) Pavement widening for a class C or class D road varies 2 to 5.5 ft (0.610 to 1.678 m) as the curvature varies from 2 to 26.7°. Values obtained may be rounded off to the nearest 0.5 ft (0.152 m).
4. Shoulders	(4)					(7) The term critical length is used to indicate the maximum length of a designated upgrade upon which a loaded truck can operate without an unreasonable reduction in speed. Critical lengths may be increased at an approximate rate of 50 ft (15.240 m) per percent decrease in grade from the values shown.
Minimum width w/o barrier curbs, ft (m)		10 (3.048)	10 (3.048)	6 (1.829)	4 (1.219)	(8) The minimum lengths of vertical curves are determined by multiplying k by the algebraic differences in grades (in percent).
Normal cross slope, rate		0.0417-0.0625	0.0417-0.0625	0.0417-0.0625	0.0417-0.0625	
Type, (perm road)		Dustless	Stable	Compacted soil	Compacted soil	
5. Bridge clearance (perm)*						
6. Curb offset for barrier curb, ft (m)		2.5 (0.762)	2.5 (0.762)	2.0 (0.610)	2.0 (0.610)	
Alignment Elements						
7. Sight distance						
Minimum stop sight distance, ft (m)		475 (144.780)	475 (144.780)	275 (83.820)	200 (60.960)	Notes:
Minimum pass sight distance, ft (m)		N/A	2,100 (640.081)	1,500 (457.201)	N/A	
8. Horizontal alignment						1. As can be seen, capacities are shown as a range of values. If maximum (or minimum) design values shown are rigidly adhered to, then the resultant capacity of the road will be on the lower side of the capacity range. Therefore, discretion should be used in selecting design values by avoiding maximums or minimums whenever possible.
Maximum horizontal curvature	(5)	5.5°	5.5°	14.5°	26.7°	2. Turnouts should be provided at 1/4-mile (402.250 m) intervals on class-D roads.
Pavement widening, ft (m)	(6)	None	None	2-4 (0.610-1.219)	2-5.5 (0.610-1.678)	
9. Vertical alignment						3. Curbs will generally not be provided in open areas.
Grade						
Maximum grade, %		6	6	10	15	
Critical length, ft (m)	(7)	700 (213.360)	700 (213.360)	450 (137.160)	250 (76.200)	
Minimum grade, %		0.3	0.3	0.3	0.3	
Vertical curves	(8)					
Overt (crest) vertical curve k, ft (m)		160 (48.788)	160 (48.788)	55 (16.764)	35 (10.668)	
Invert (sag) vertical curve k, ft (m)		105 (32.004)	105 (32.004)	55 (16.764)	28 (8.534)	
Absolute minimum length, ft (m)		180 (54.864)	180 (54.864)	120 (36.576)	80 (24.384)	

\*Bridge clearance (permanent) width of the traveled way should be equal to the width of the lanes plus 5 ft (1.524 m) [2.5 ft (0.762 m)] on each side; 14.75 ft (4.498 m) vertical clearance.

# CRITERIA

- Average Daily Traffic (ADT) or Designed Hourly Volume (DHV)
  - Rule of thumb: number of vehicles per unit that will be using road multiplied by 2
- Refer to FM 5-430-00-1 Figure 9-3

# TABLE 9-3

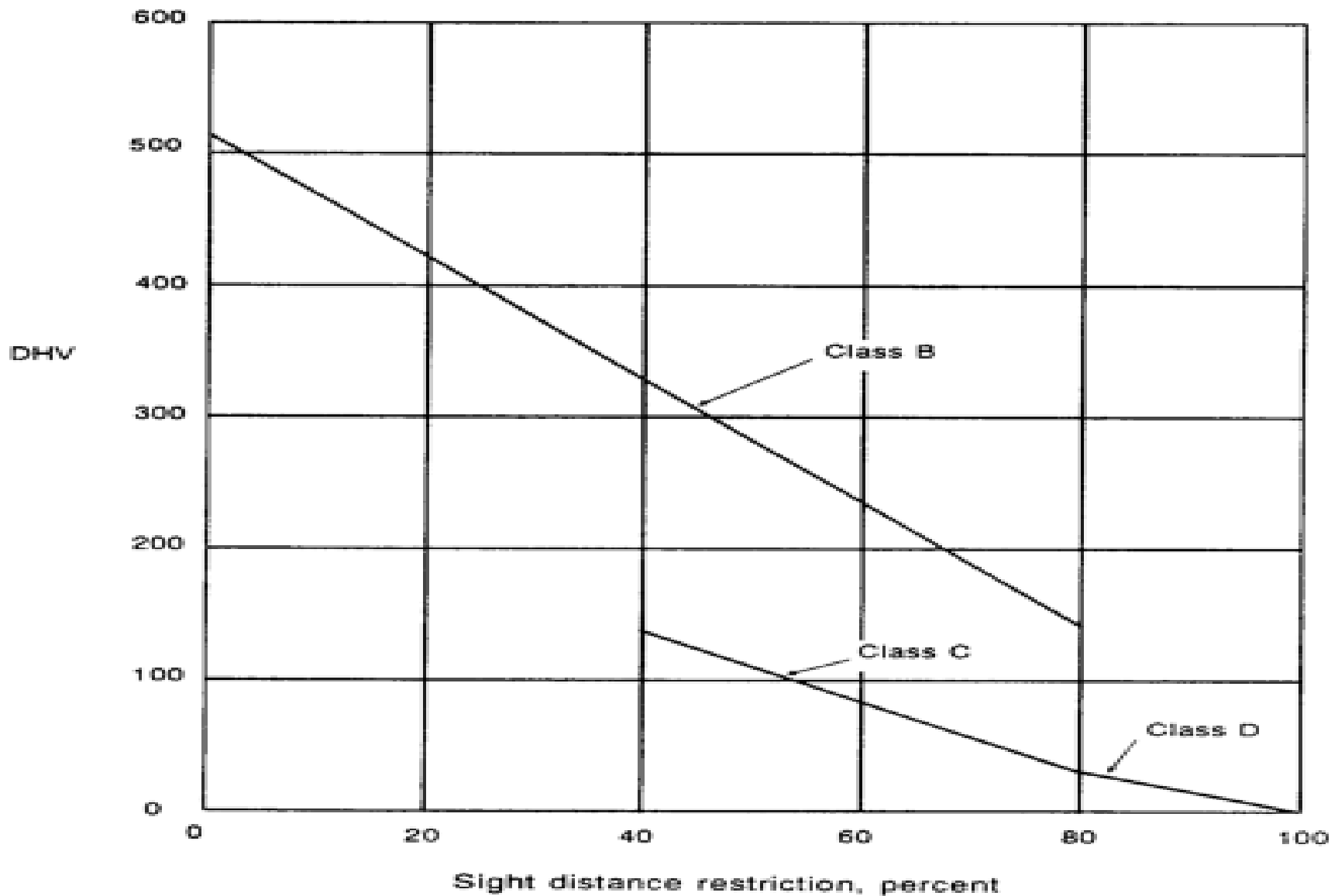


Figure 9-3. Interpolation of DHV for selection of road class (not to scale)

# ADT & DHV FORMULAS:

**Example:** A road is to be constructed for an estimated 250 vehicles.

**Step #1: Compute Average Daily Traffic (ADT).**

- **ADT = No# of vehicles x 2 (round trip)**
  - $250 \times 2 = 500$  vehicles per day.

**Step #2: Compute Design Hourly Volume (DHV).**

- **#DHV = No# vehicles per day x 0.15 (rush hour constant).**
  - $500 \times 0.15 = 75$  vehicles per hour.
  - **DHV = No# vehicles per day / 24 (hours in 1 day).**
  - $500 / 24 = 21$  vehicles per hour.

**Step #3: Compare computed values to design controls to determine which class of road is required.**

# GRADE AND ALIGNMENT

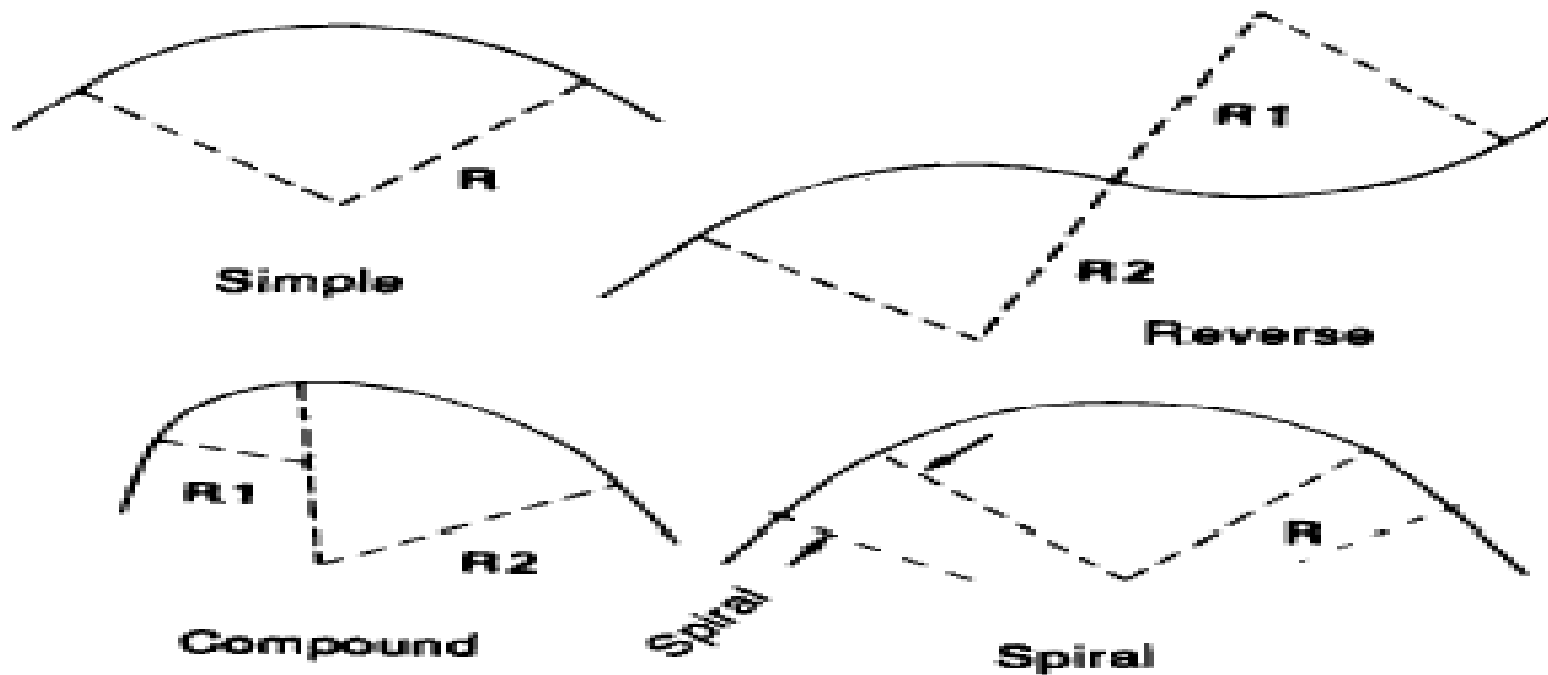
- Usability of the route is directly related to the degree of curvature for both horizontal and vertical curves
  - As a general rule--- the fewer the curves the better

# HORIZONTAL ALIGNMENT AND CURVES

- Make curves as gentle as possible
  - Lengthening the curves will shorten the tangents.
- Tangents should intersect existing roads (and railroads) at right angles
- The most common types are the; simple, compound, reverse and

# HORIZONTAL ALIGNMENT AND CURVES

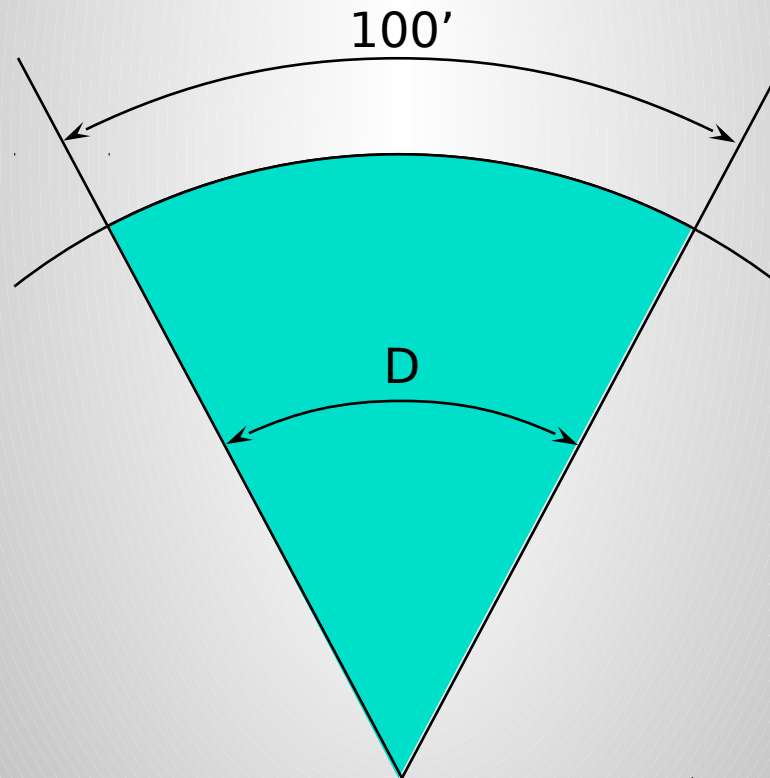
- The spiral is used only on class A & B routes therefore they will not be used.



*Figure 9-4. Types of horizontal curves*

# DEGREE OF CURVE

The Degree of Curve (D) is defined by the angle subtended by 100 feet of circular arc.



# VERTICAL ALIGNMENT

- Excessive grades have tremendous impact on traffic
  - Maintain within values found on table 9-1, FM 5-430-00-1
- Care must be taken during design to ensure best grades are achieved and earthwork is kept at a minimum

# VERTICAL ALIGNMENT

- Points of fixed elevation:
  - Existing roads (and railroads), Bridges and streams
- Criteria for grades:
  - Minimum gradients
  - Max allowable change in grade at Intersection points
  - Permissible depth of cut/fill
  - Max approach gradients (to bridges or intersections)

# QUESTIONS?



# **STRUCTURAL DESIGN**

- Military roads will most commonly be surfaced with natural, indigenous materials
- Expedient surfacing methods used when required

# EARTHEN ROADS

- Native soils hastily formed to satisfy immediate traffic needs.
- Can be used as a sub-grade for more deliberate surface
- Generally limited to dry weather and light traffic
- Maintenance is required by graders and/or drags
- Dust control must be considered in dry climates
- Earthen road surfaces can be treated with admixtures to provide strength during wet weather

# STABILIZED SOILS

- Surface and subsequent layers stabilized with bituminous materials or other admixtures (cement)
- Bearing surface should have
  - Maximum Sized Aggregate (MSA) of 1" – 1.5" (preferred)
  - 10% - 25% fines

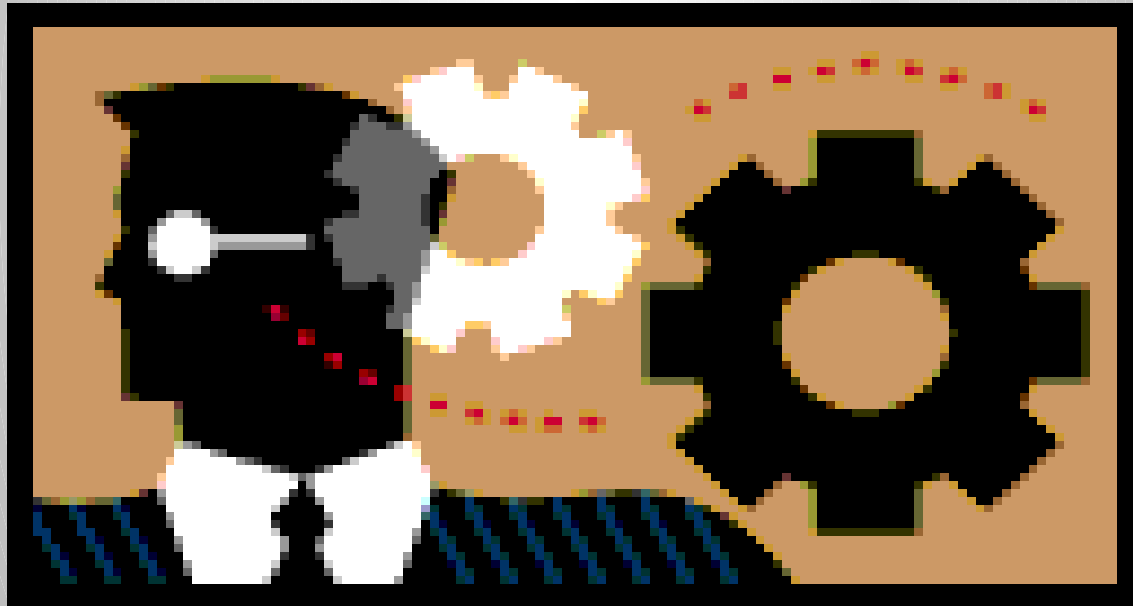
# SAND/CLAY

- Mechanically stabilized soil surface
  - Addition of fine gravel will add stability
- Works well for light traffic (usually)
- Maintenance is required
  - dust abatement, blading and dragging

# GRAVEL

- Constructed of a compacted layer material consisting of 30% gravel with a MSA of 1" to 1.5"
- Angular materials are best
- Rounded materials may be used but will usually require additives to act as binding agents
- Requires maintenance

# QUESTIONS



# **GENERAL ROAD STRUCTURAL DESIGN**

- Unsurfaced or Aggregate systems
- Class (A-G)
- Design Index (1-10)
- Design Category (I-VII)

# CLASSES

*Table 9-8. Road-class selection criteria*

Road Class	Number of Vehicles Per Day
A . . . . .	10,000
B . . . . .	8,400-10,000
C . . . . .	6,300-8,400
D . . . . .	2,100-6,300
E . . . . .	210-2,100
F . . . . .	70-210
G . . . . .	Under 70

# DESIGN INDEX

- Vehicle Groups:
  - Group 1- Passenger cars and pickup trucks
  - Group 2- Two-axle trucks (excluding pickup trucks)
  - Group 3- Three, four, and five axle trucks

# TRAFFIC CATEGORIES

**Table 9-9. Pneumatic-tired traffic categories based on traffic composition**

Traffic Category	Percentage of total traffic for vehicle groups		
	Group 1	Group 2	Group 3
Category I	$\geq 99\%$	$\leq 1\%$	
Category II	$\geq 90\%$	$\leq 10\%$	
Category III	$\geq 84\%$	$\leq 15\%$	$\leq 1\%$
Category IV	$\geq 65\%$	$\leq 25\%$	$\leq 10\%$
Category IVA	Any amount	$> 25\%$	$> 10\%$

# DESIGN INDEX

**Table 9-10. Design index for pneumatic-tired vehicles**

Design Index					
Class	Category I	Category II	Category III	Category IV	Category IVA
A	2	3	4	5	6
B	2	2	4	5	6
C	2	2	4	5	6
D	1	2	3	4	5
E	1	2	3	4	5
F	1	1	2	3	4
G	1	1	1	2	2

# TRACKED/FORKLIFT CATEGORIES

*Table 9-11. Tracked-vehicle and forklift traffic categories*

Category	Vehicle Weight, Pounds	
	Tracked Vehicles	Forklift Trucks
V	40,001-60,000	10,001-15,000
VI	60,001-90,000	15,001-25,000
VII	Over 90,000	Over 25,000

# DESIGN INDEX (TRACK/FORKS)

*Table 9-12. Design index for tracked vehicles and forklifts*

Traffic Category	Number of Vehicles per Day (or Week as Indicated)							
	500	200	100	40	10	4	1	1 Per Week
V	6	6	6	6	5	5	5	--
VI	9	8	7	6	6	6	5	5
VII	10	10	9	9	8	7	6	5

**NOTE:** If number of vehicles is between values, round up to the next higher number.

# UNSURFACED ROADS

- (1) Estimate the number of passes of each type of vehicle expected to use a road on a daily basis.
- (2) Select the proper road class based upon the traffic intensity from Table 9-8.
- (3) Determine the traffic category based upon the traffic composition criteria shown in Table 9-9.
- (4) Determine the design index from Table 9-10 or Table 9-12.
- (5) Read the soil-surface strength required to support the design index from Figure 9-50.

# UNSURFACED ROADS, CBR REQUIREMENT

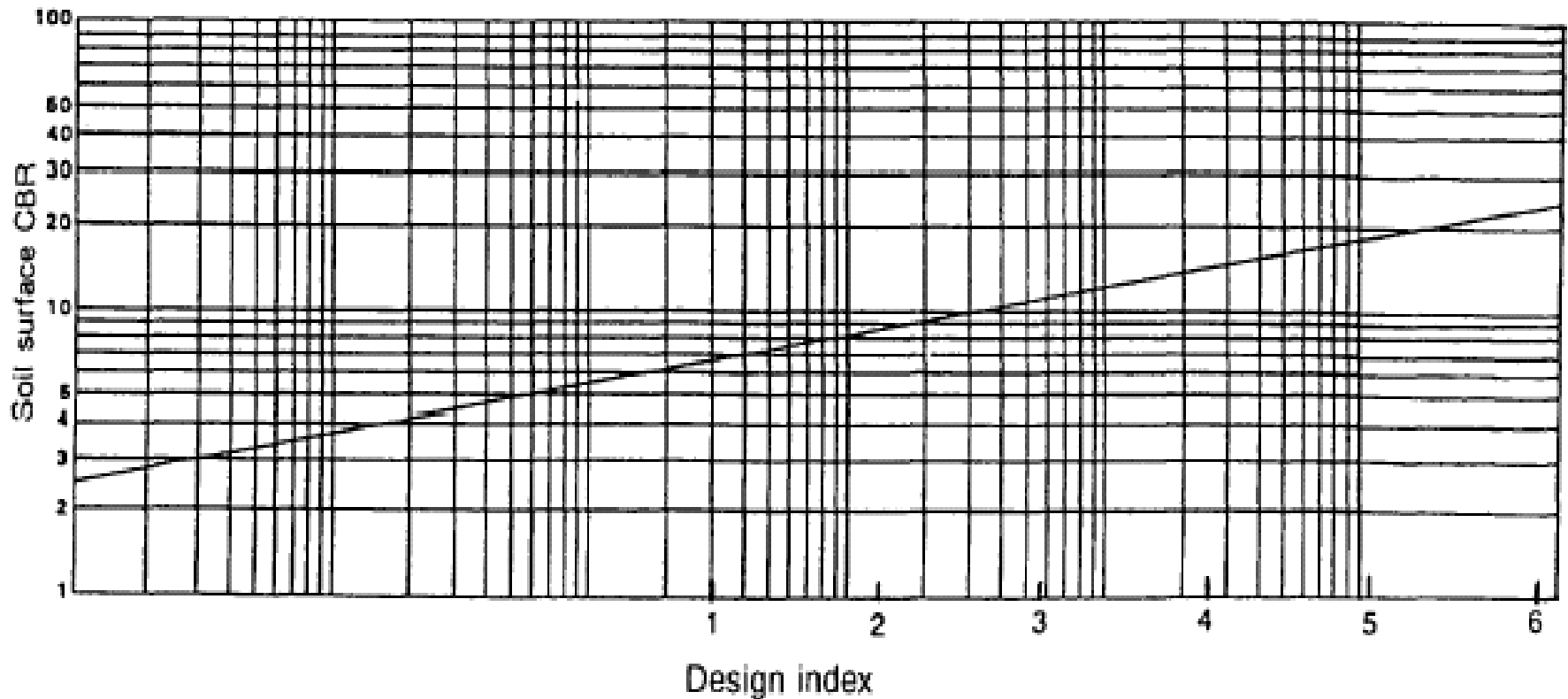


Figure 9-50. Unsurfaced-soil strength requirements

# THICKNESS REQUIREMENTS

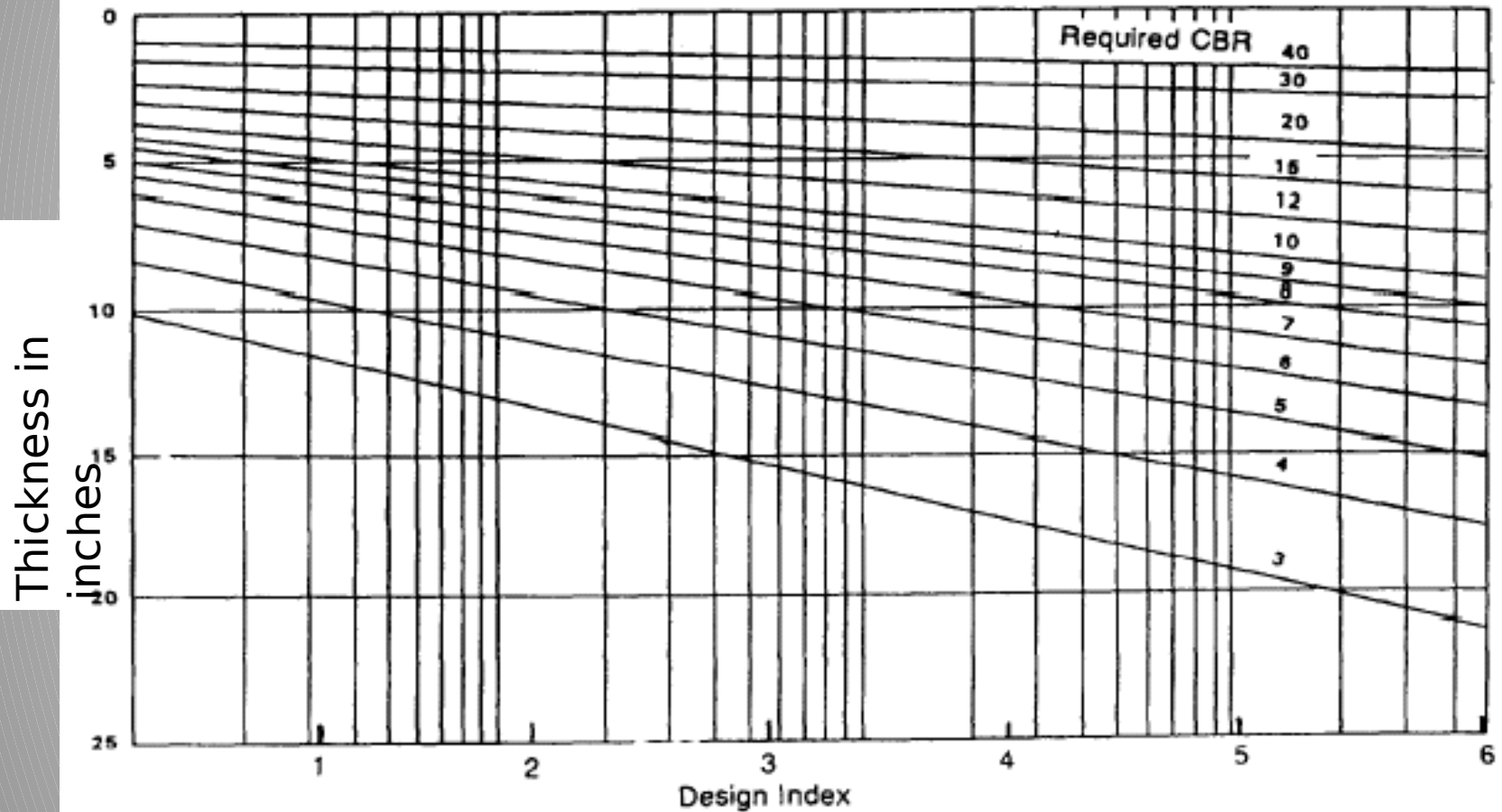


Figure 9-51. Unsurfaced-soil thickness requirements

# EXAMPLE

<u>Vehicle</u>	<u>Average Daily Traffic</u>
M998 HMMWV (two axle)	_____ 180
M929 5-ton Dump (three axle)	50

# EXAMPLE/SOLUTION

- **1. Determine the average daily traffic (given).**
- **2. Select road class E from Table 9-8, based upon 230 vehicles per day.**
- **3. Select traffic category IVA, based upon the percentage of Group 3 vehicles.**
- **4. The design index is 3 from Table 9-10.**
- **5. The soil-surface strength requirement for a design index of 3 is 10.8 CBR.**
- **6. Check to ensure the design CBR value of the in-place soil exceeds the 10.8 CBR required. If not, consider using either soil stabilization or an aggregate road.**
- **7. Determine the required unsurfaced-soil thickness from Figure 9-51. Given a design index of 3 and a required CBR of 10.8, the required thickness from Figure 9-51 is 6 inches.**

# AGGREGATED-SURFACE ROADS

Materials- Refer to Chapter 5 FM 5-4300-00-1  
(capable of obtaining CBR or 50 or better,  $MSA \leq 3''$ )

Higher quality to lower quality

Select and sub-base materials

*Table 9-13. Compaction criteria and CBR requirements for an aggregate road structure*

CBR requirements	Layer	Compaction requirements
50, 80, 100	Base course	100 - 105%
20 - 50	Subbase course	100 - 105%
0 - 20	Select material	Cohesive: 90 - 95% Cohesionless: 95 - 100%
	Design subgrade (SCIP)	Cohesive: 90 - 95% Cohesionless: 95 - 100%
	Uncompacted subgrade	

**NOTES:**

1. All lifts in a road design must be at least 4 inches.
2. A cohesive soil is one with a PI above 5.
3. A cohesionless soil is one with a PI of 5 or less.
4. Percent compaction is compared to the CE 55 curve according to ASTM D1557.

# AGGREGATED-SURFACE ROADS

Base Course – Best materials

Design requirements----

Thickness requirements

Look at enclosure (2)

*Table 9-15. Assigned CBR ratings for base-course materials - aggregate-surfaced road*

Number	Type	Design CBR
1	Graded crushed aggregate	100
2	Water-bound macadam	100
3	Dry-bound macadam	100
4	Lime rock	80
5	Stabilized aggregate	80
6	Soil cement	80
7	Sand shell or shell	80

**NOTE:** It is recommended that stabilized-aggregate base-course material not be used for tire pressures in excess of 100 psi.

# AGGREGATED-SURFACE ROADS

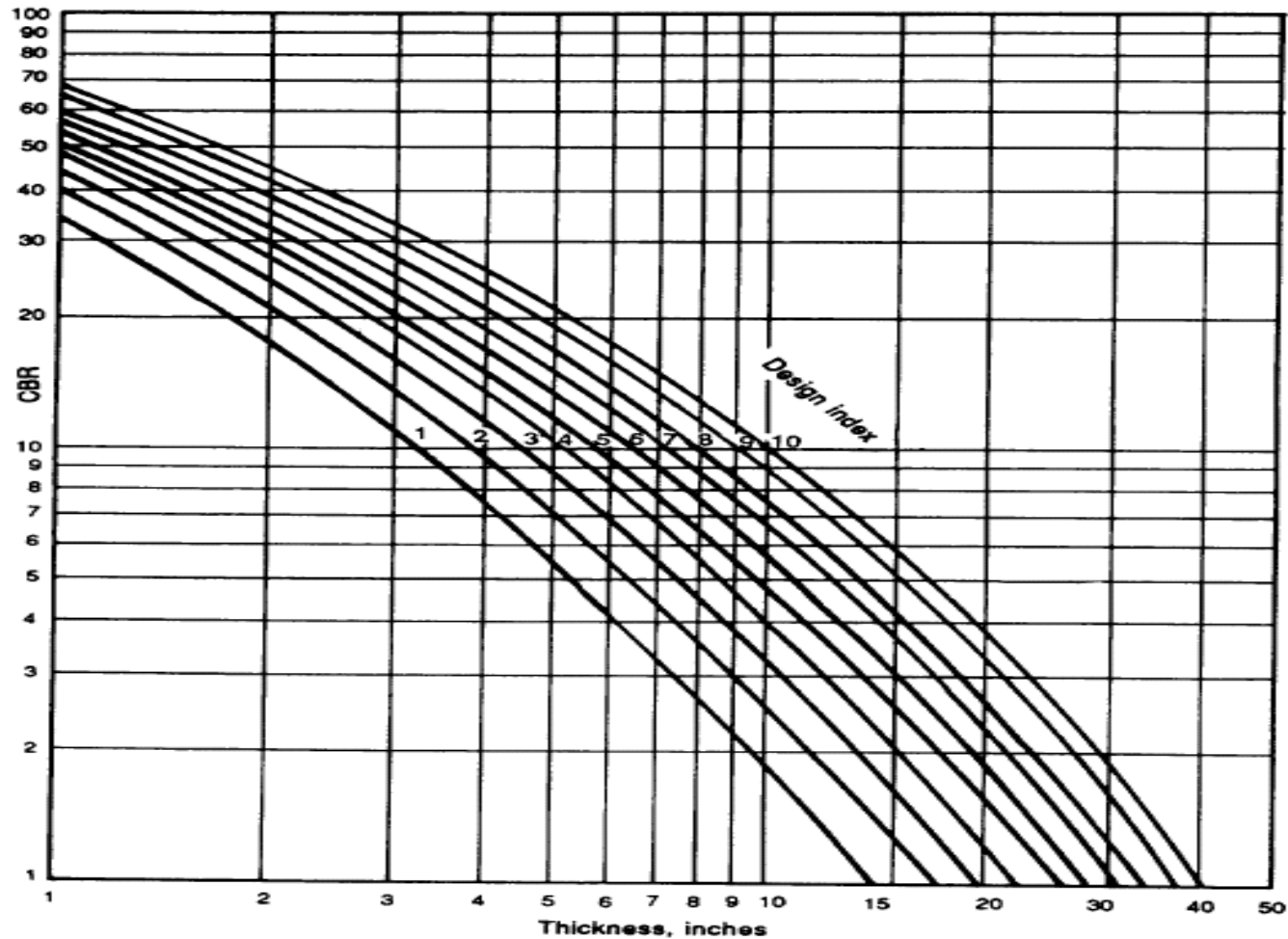


Figure 9-52. Design curves for aggregate-surfaced roads.

# DEPTH OF COMPACTION

**Table 9-16. Required depth of subgrade compaction for roads, cohesionless soils**

Percent Compaction	Depth of Compaction (In Inches) for Indicated Design Index									
	1	2	3	4	5	6	7	8	9	10
95-100 <sup>1</sup>	7	8	10	11	12	14	15	17	19	21
90-95 <sup>2</sup>	10	12	14	16	18	20	22	24	28	30

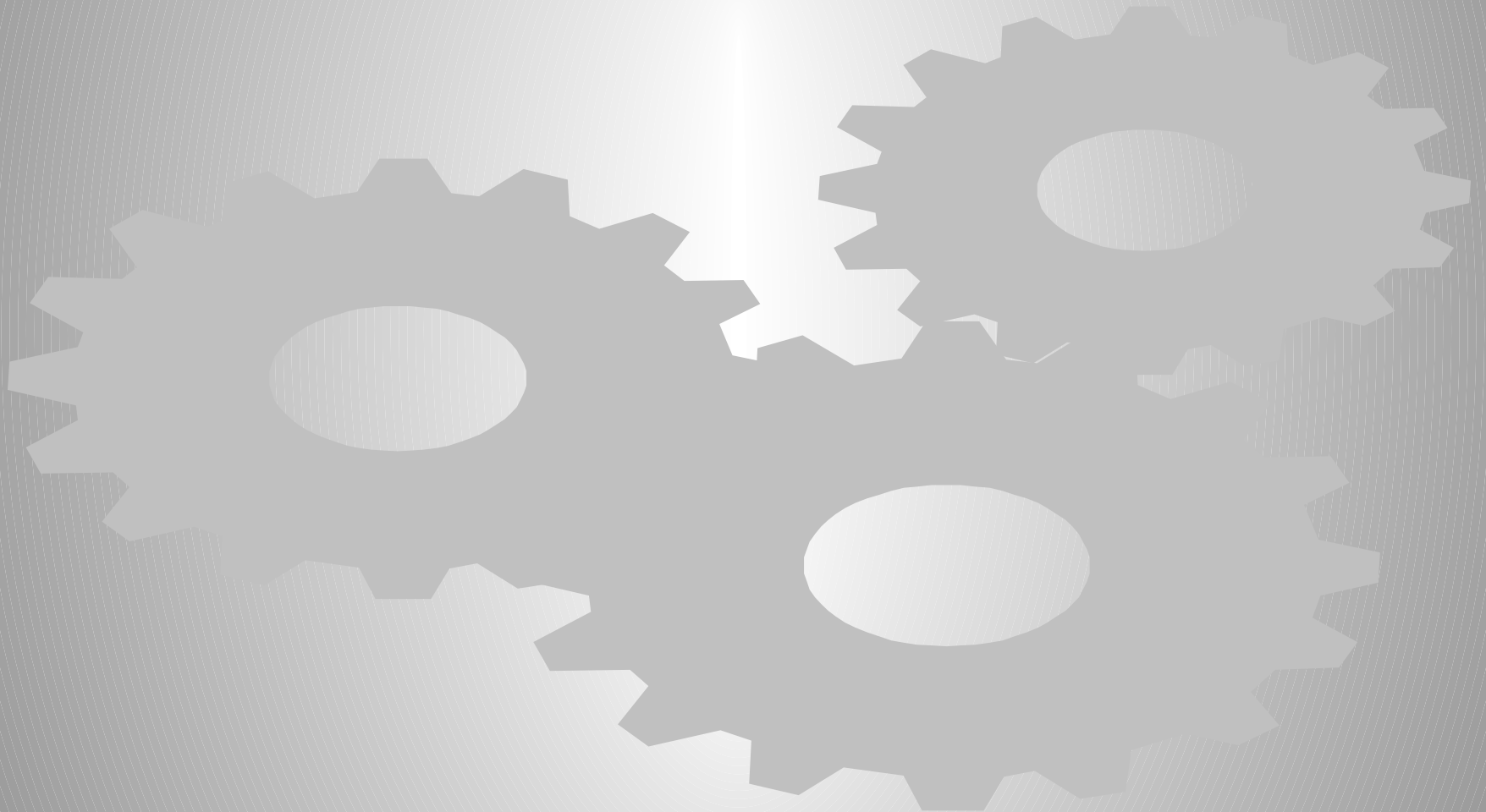
<sup>1</sup>Normally used.  
<sup>2</sup>Use if on-site test strip results show the 95-100 range is not attainable.

**Table 9-17. Required depth of subgrade compaction for roads, cohesive soils (PI>5)**

Percent Compaction	Depth of Compaction (In Inches) for Indicated Design Index									
	1	2	3	4	5	6	7	8	9	10
90-95 <sup>1</sup>	6	7	8	9	10	11	12	13	15	17
95-100 <sup>2</sup>	6	6	6	6	7	7	8	9	10	11

<sup>1</sup>Normally used.  
<sup>2</sup>Use if on-site test strip results show these ranges are attainable, and shear failure is unlikely..

# QUESTIONS?



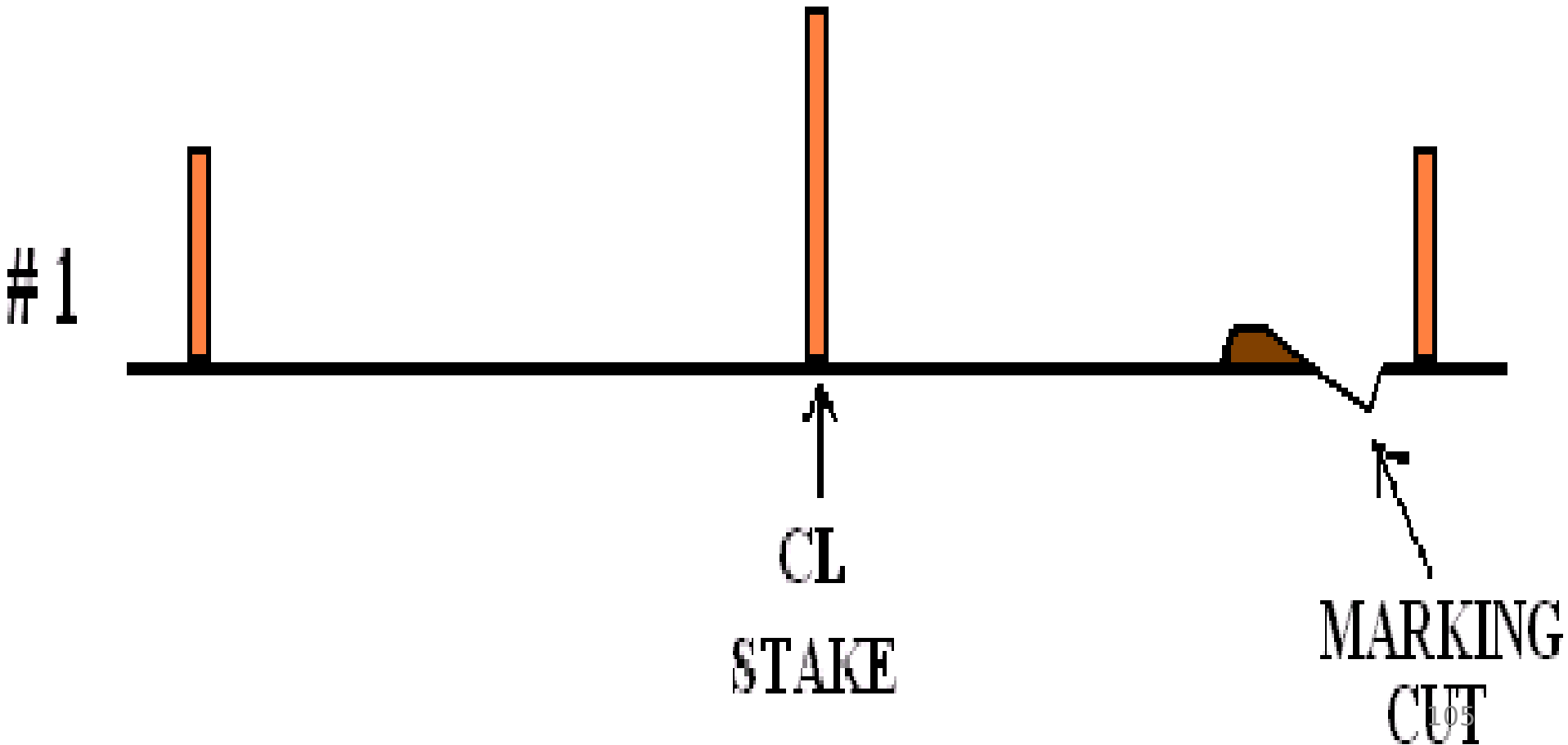
# 7 STEP MILITARY ROAD

- Depending on time and assets, Military Roads will either be Deliberate or Hasty
- Deliberate
  - Surveyed and staked
  - Quarry materials used
  - Designed for long-term usage
- Hasty
  - Temporary in nature
  - Repairing existing roads
  - Use indigenous materials

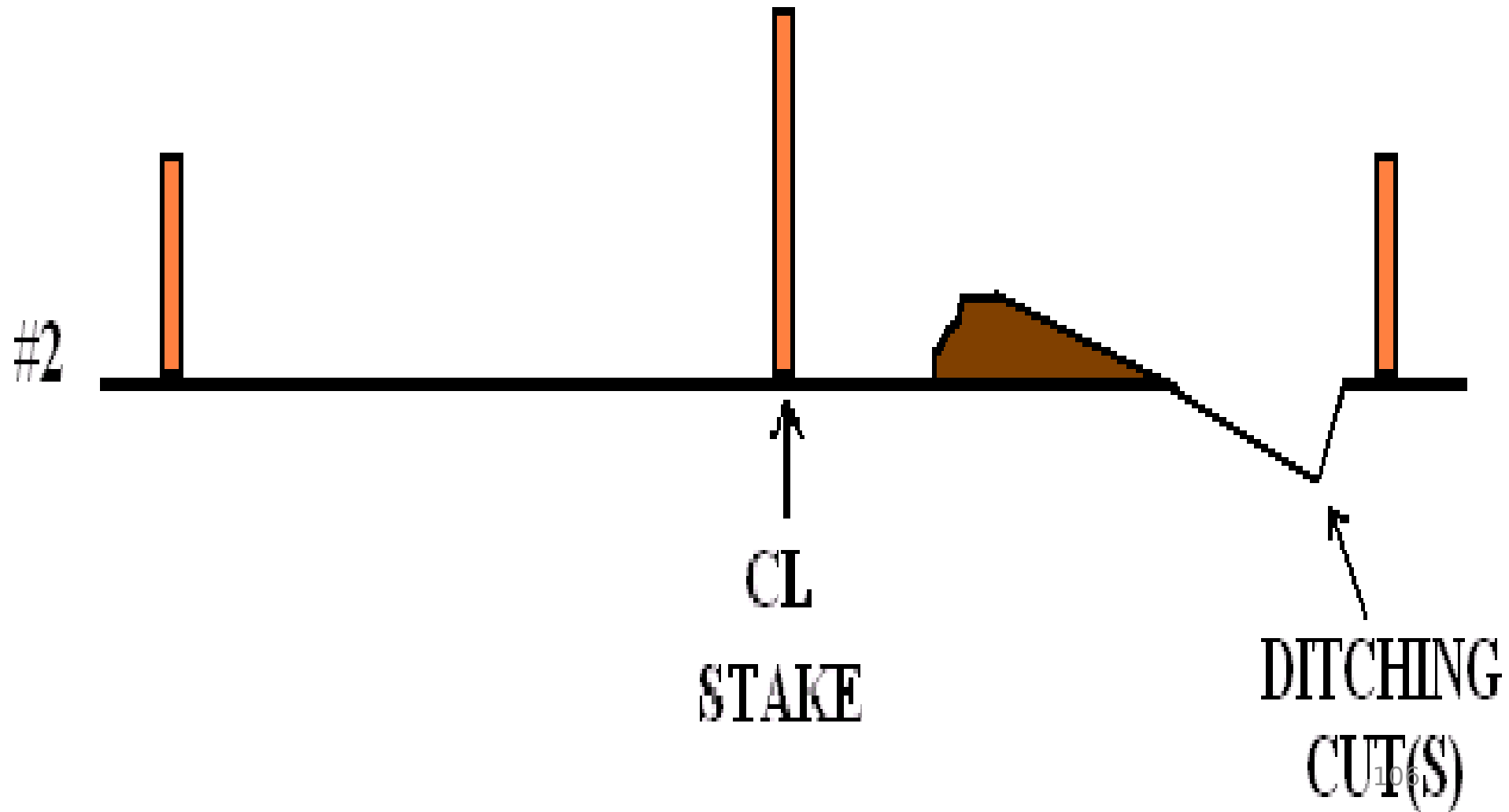
# **Seven Step Military Road**

- Always clear, strip, and grub before employing these procedures if possible.
- These steps are just that “steps” and not passes; it may take the grader several passes to achieve each step.

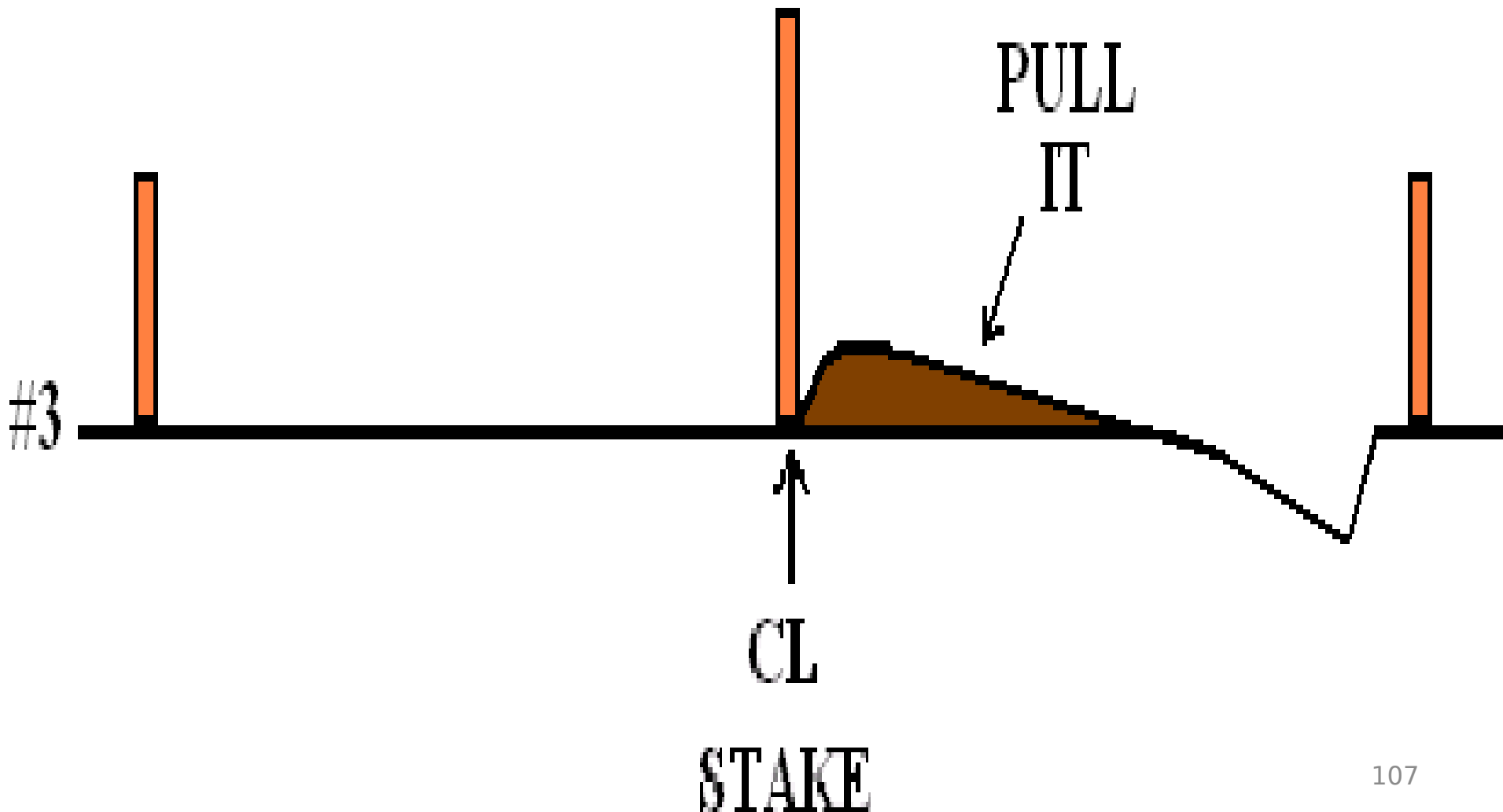
# STEP #1 - MARK IT (MARKS THE DITCH LINE)



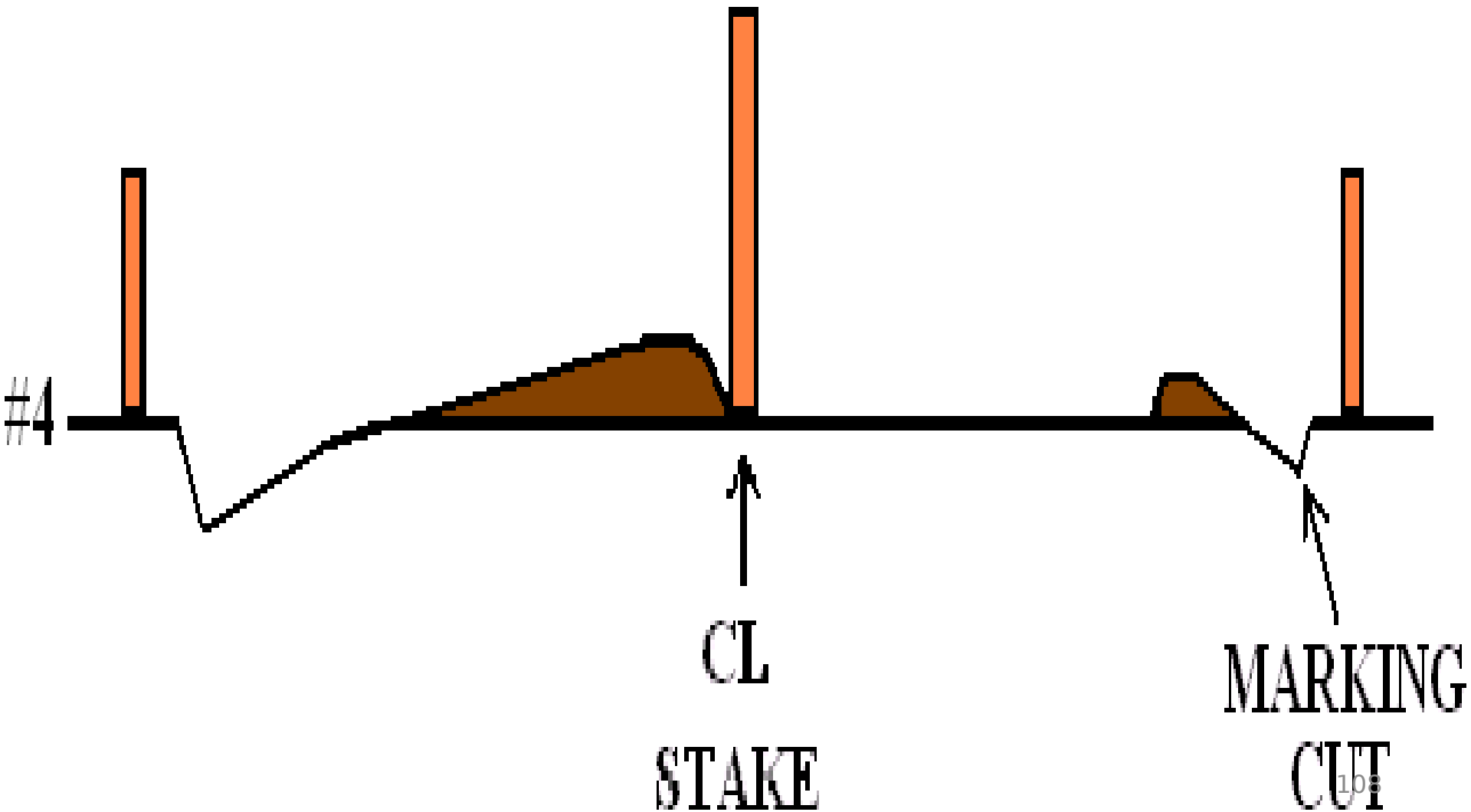
# STEP #2 - CUT IT (FORMS THE DITCH)



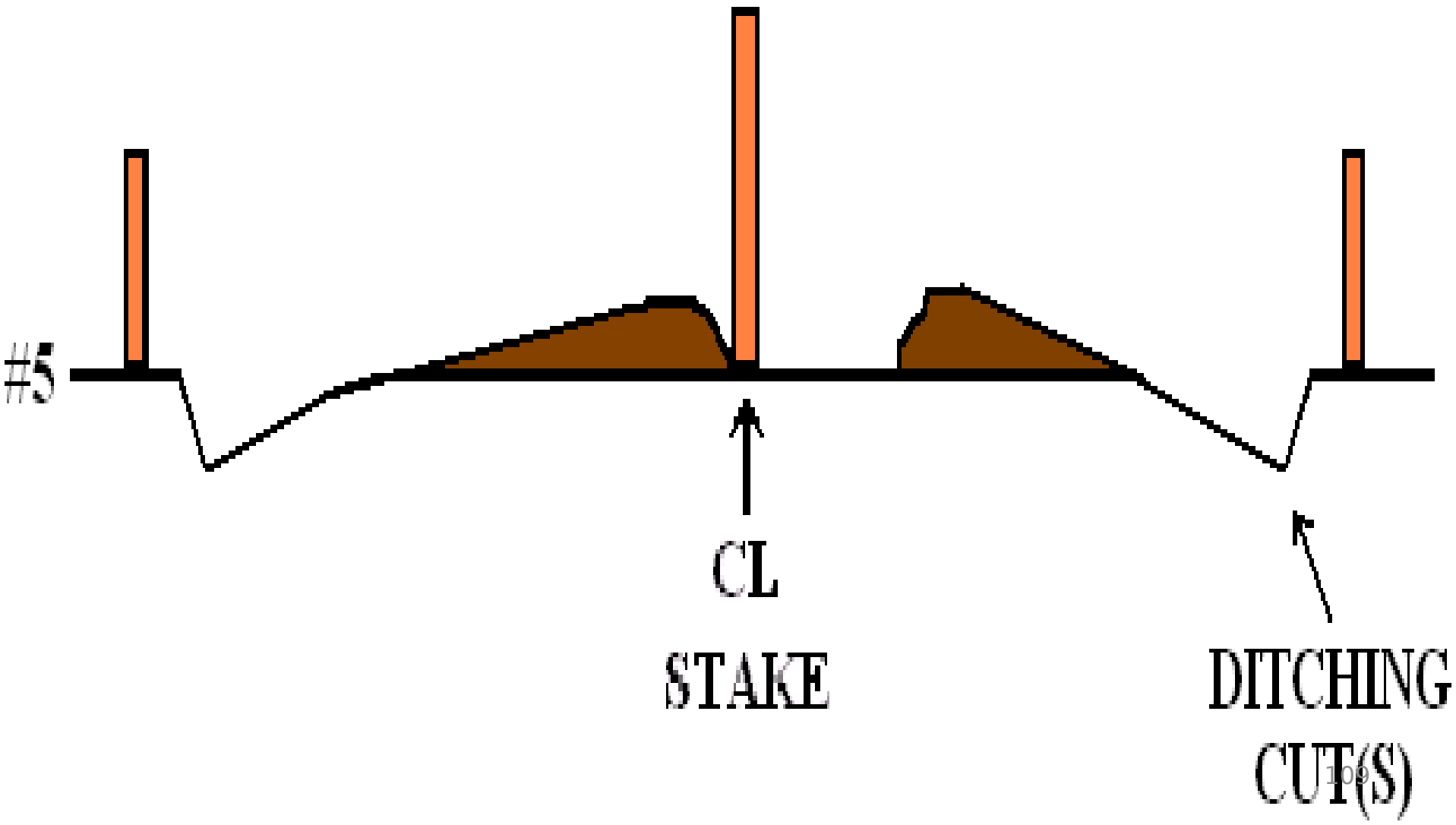
# STEP # 3 - PULL IT (CREATES THE SHOULDER)



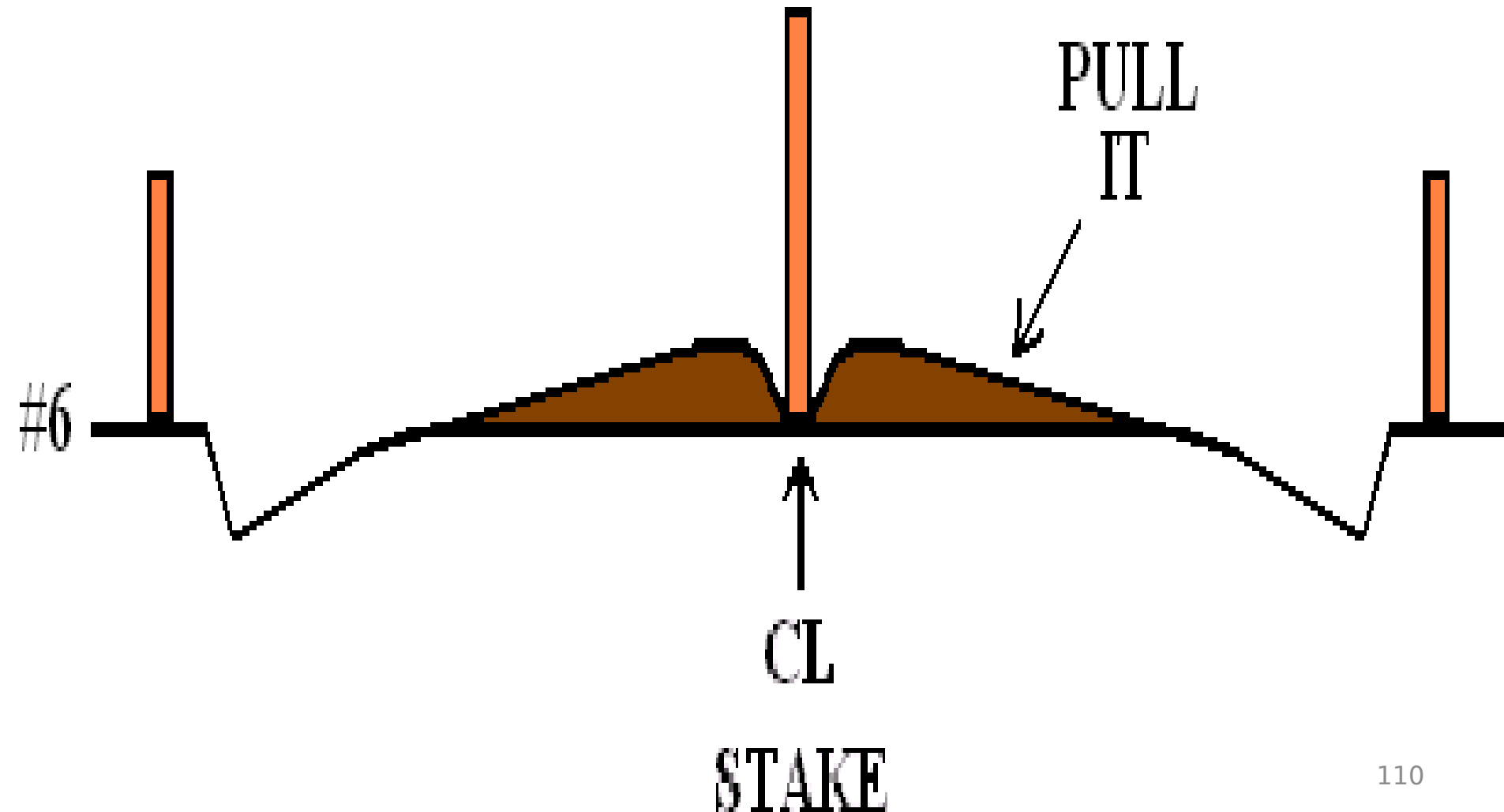
# STEP #4 - MARK IT (MARKS THE DITCH LINE)



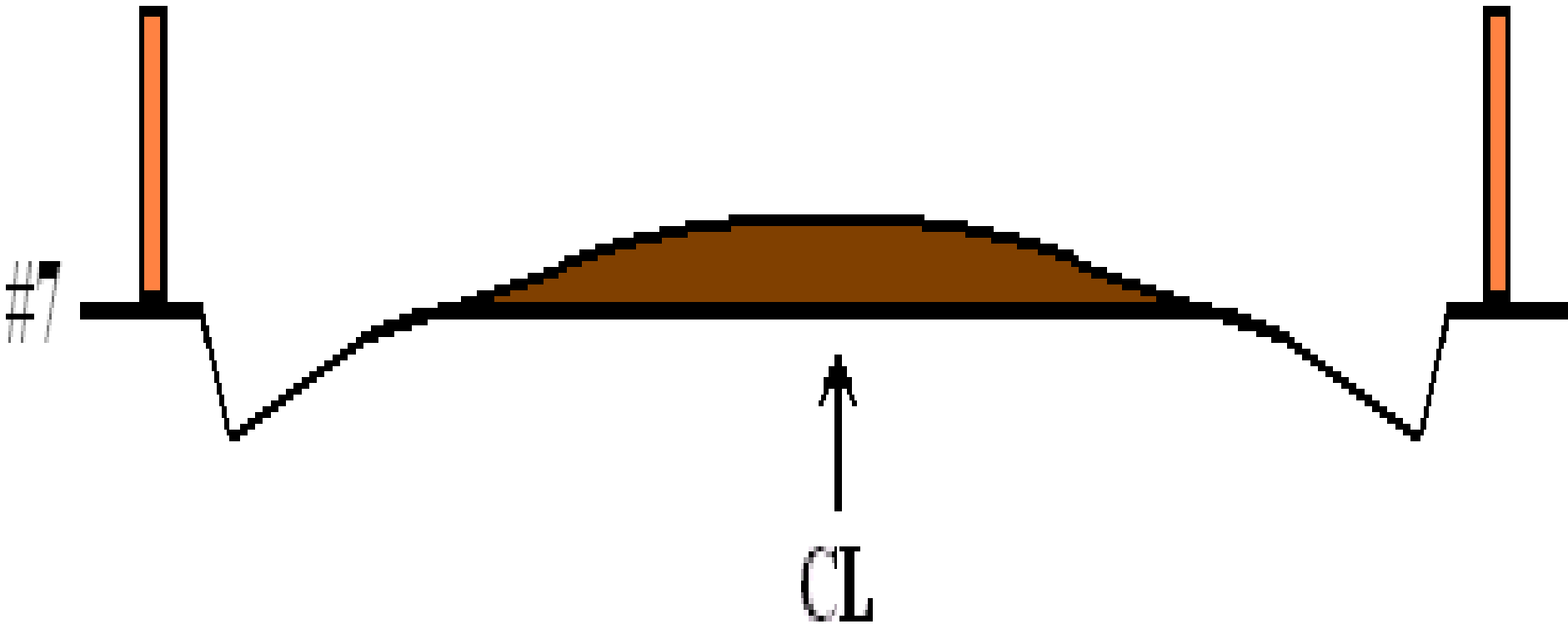
# STEP #5 - CUT IT (FORMS THE DITCH)



# STEP #6 - PULL IT (CREATES THE SHOULDER)



# STEP #7 - CROWN IT (CREATES THE CROWN)



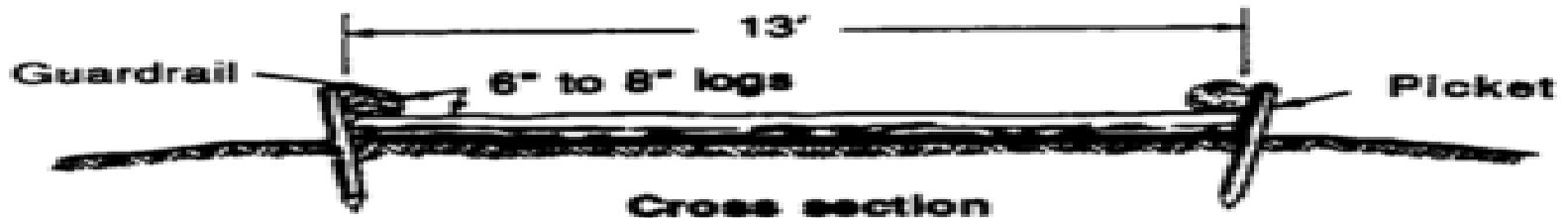
# QUESTIONS



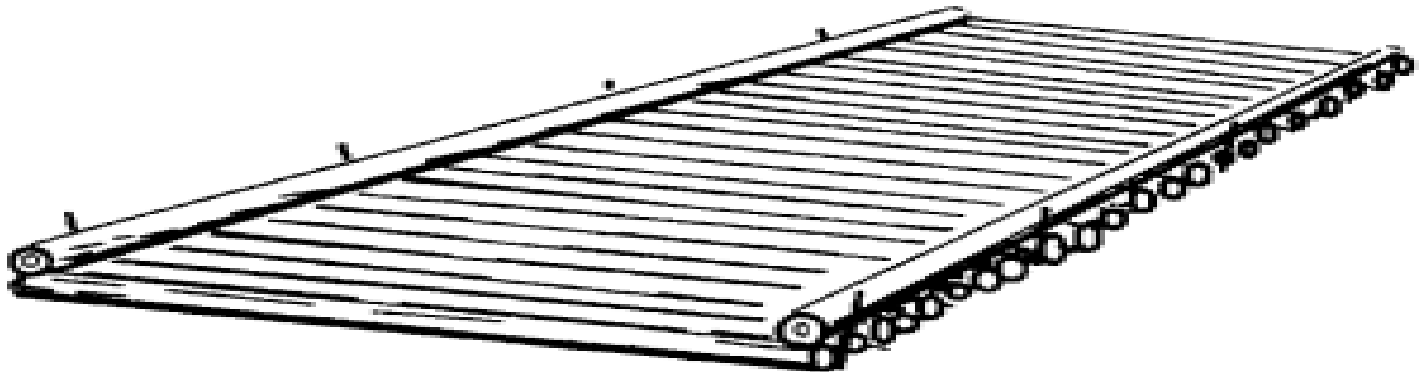
# **EXPEDIENT SURFACE ROADS**

- Several types
  - Corduroy
  - Chespalling
  - Landing mats
  - Plank tread
  - Sand grid

# CORDUROY

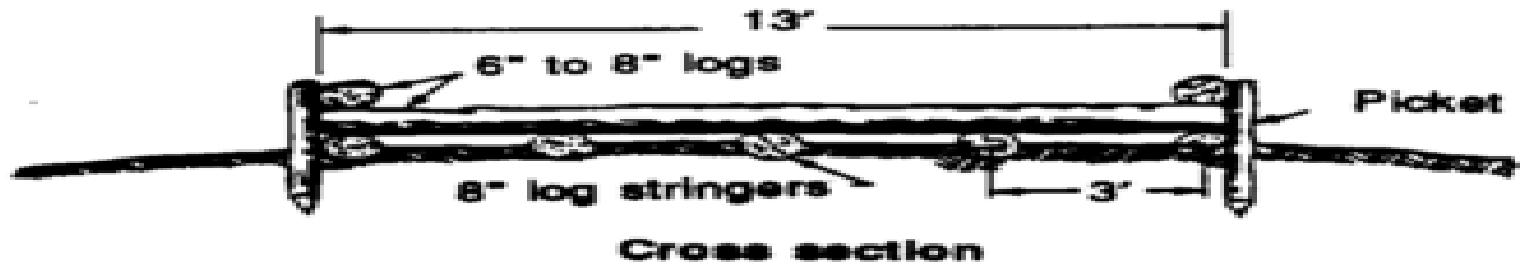


*Figure 9-25. Standard corduroy*

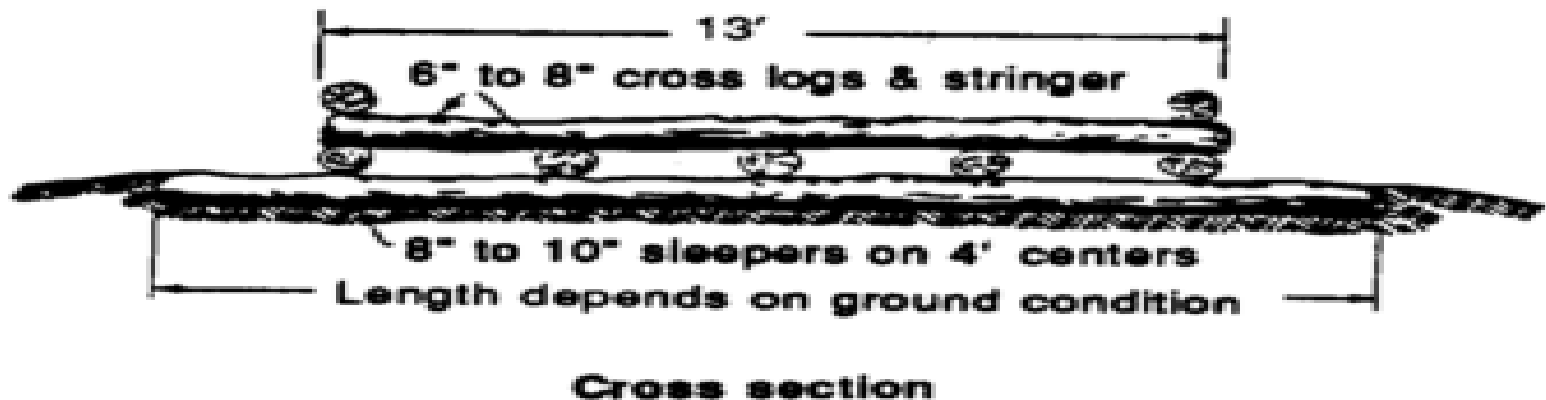


*Figure 9-26. Standard corduroy - oblique view*

# CORDUROY



*Figure 9-27. Corduroy with stringers*



*Figure 9-28. Heavy corduroy*

# CHESPALING



*Figure 9-29. Chespaling*

# LANDING MAT

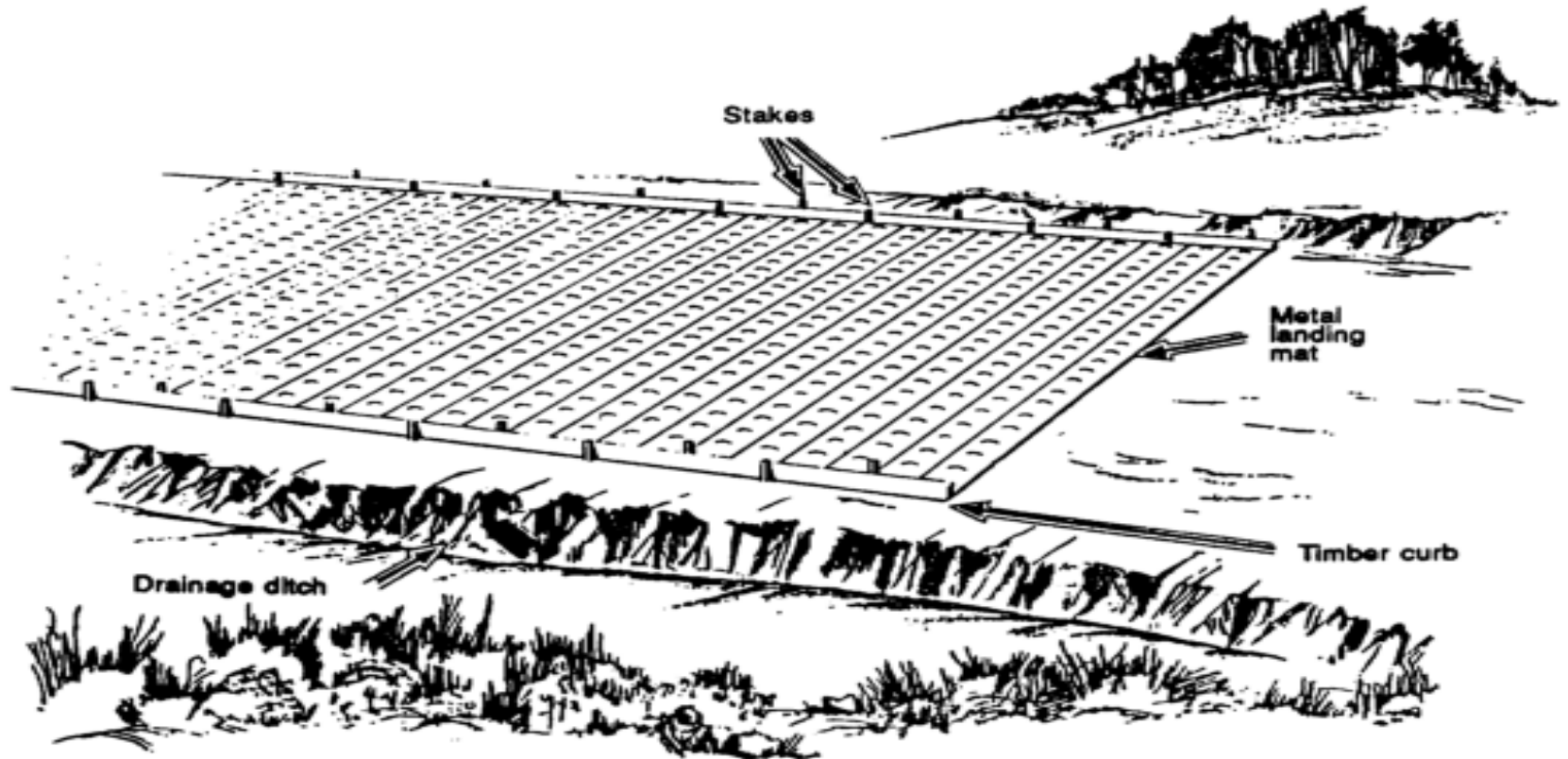
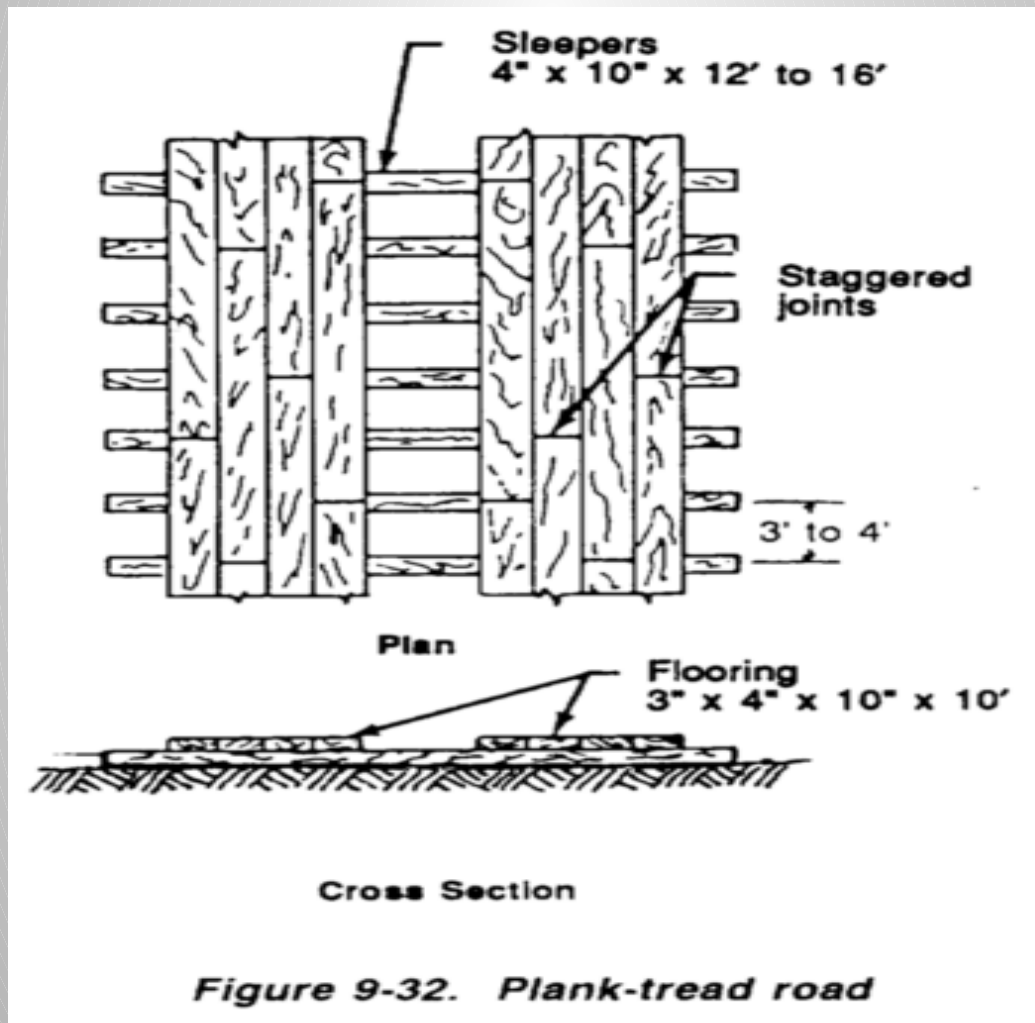
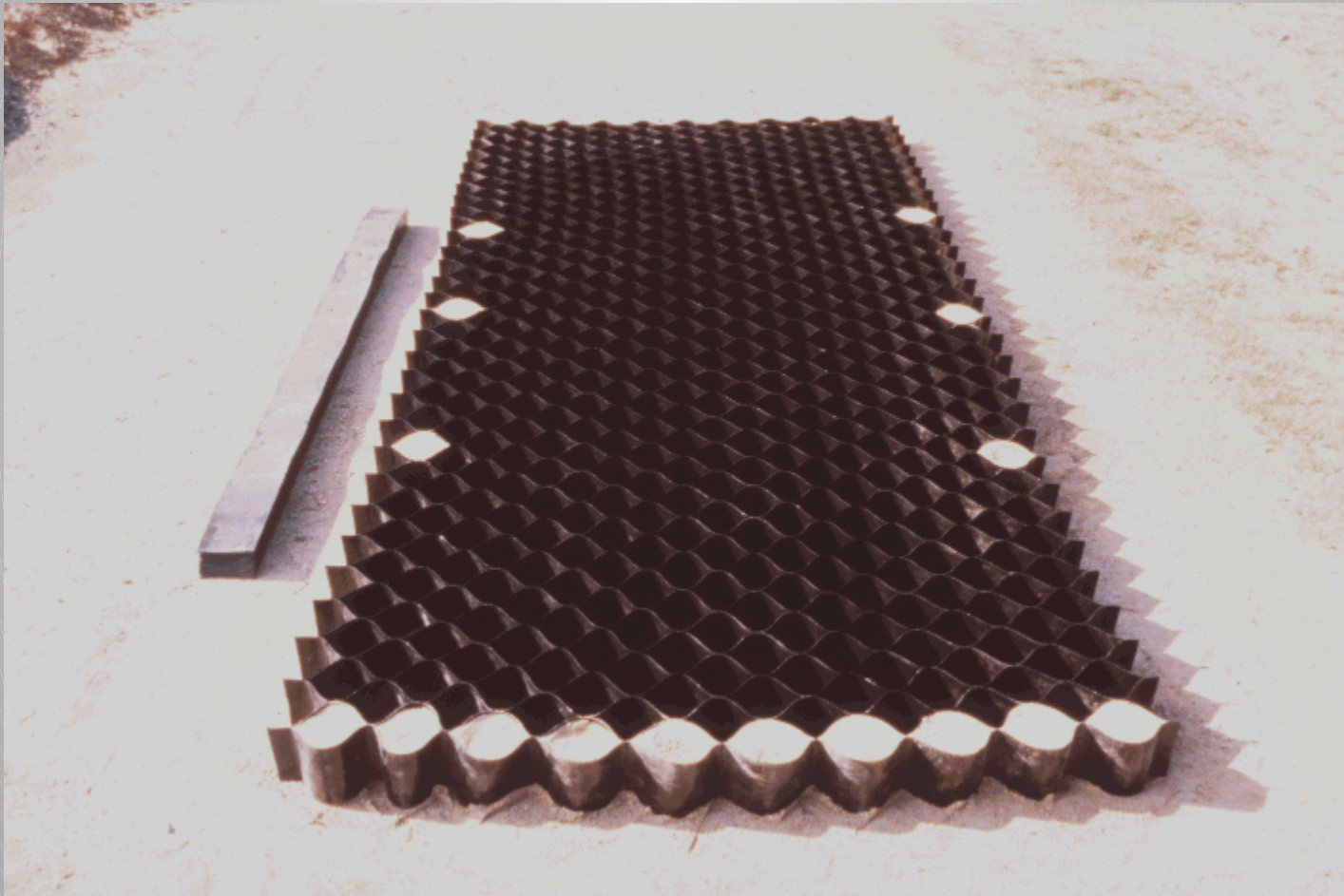


Figure 9-30. Landing-mat road

# PLANK-TREAD



# SAND GRID



# QUESTIONS